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# THE JOURNAL OF PERIODONTOLOGY

July
1954

*Published by*
THE AMERICAN ACADEMY OF PERIODONTOLOGY
VOLUME 25
NUMBER 3

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*THE JOURNAL OF PERIODONTOLOGY* is published to serve as the professional journal of periodontia; to keep dentists in touch with research being carried on in this field and related sciences; to stimulate greater interest in the supporting tissues of the teeth and their relation to oral and general health.

The Journal is the official organ of the American Academy of Periodontology and will contain, therefore, papers of scientific and clinical interest which are presented at the annual meetings of that society, as well as articles submitted direct to the Editor. Obviously opinions expressed do not necessarily represent those of the Editor or the American Academy of Periodontology.

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*Thirty-eighth Annual Meeting*

THE AMERICAN ACADEMY OF PERIODONTOLOGY

November 4, 5, 6, 1954

Miami Beach, Florida

DONALD A. KERR, A.B., D.D.S., M.S.

*Chairman Scientific Sessions, Thirty-eighth Annual Meeting*
*American Academy of Periodontology*

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THE JOURNAL OF PERIODONTOLOGY

JULY, NINETEEN HUNDRED FIFTY-FOUR

# The Gingival Sulcus and the Periodontal Pocket Immediately Following Scaling of Teeth

*by* SIGURD RAMFJORD* AND GORDON KIESTER,* *Ann Arbor, Michigan*

THE clinical and histopathologic features of gingival and periodontal pockets in relation to therapeutic procedures have been discussed in several recent publications.[1, 2, 8, 9] The wide variety of opinions expressed on the nature and response of the epithelial attachment to therapeutic measures appears very confusing to the practitioner. Because of the apparent confusion regarding this problem, a clinical and histologic study of gingival and periodontal pockets was initiated using various intervals of time following common therapeutic procedures.

This report will deal with the histologic findings in specimens obtained immediately following scaling of teeth for removal of plaques and subgingival calculus.

## MATERIAL

The specimens were obtained from patients who needed partial resection of the alveolar process in association with insertion of prosthetic appliances. A technic was developed for removal of suitable specimens of the type shown in Fig. 1. Buccal and some interproximal soft tissues with 2 to 4 mm. depth of alveolar process were separated surgically from the surrounding tissues. A sharp knife was used and attempts made to leave the soft tissue attachment to the tooth undisturbed. Periosteal flaps were elevated from the specimen, and diamond discs or sharp burrs were used to cut through the bone into the tooth at the periphery of the soft tissue specimens without the disc or the burr touching the soft tissue. Then the tooth with the adherent soft tissue was carefully removed. Immediately before this procedure a routine scaling of the tooth was performed. A deliberate, but careful attempt, was made to nick the surface of the cementum for a reference mark by utilizing a very definite finger rest to prevent any slip of the instrument, and moving a curette in a coronal direction from the bottom of the pocket. (Bunting's curettes No. 5 and No. 6, made by S. S. White, were used for the scaling and the marking of the surface of the tooth.) Two teachers of periodontics each scaled about half of the teeth. No flushing or rinsing of the pocket was done following the scaling. As a matter of convenience, the mesiobuccal, buccal, and distobuccal areas of mandibular and maxillary anterior teeth were selected for the investigation.

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From each specimen numerous sections were prepared for microscopic study. Specimens that contained artifacts from accidental trauma during the surgical removal were discarded. Microscopic study showed that nine of fourteen specimens were free from soft tissue distortion and could be used. Clearly recognizable markings from the scaling could be located on these teeth. These nine specimens were obtained from patients varying in age from 18 to 58 years of age, and with clinical diagnoses varying from "normal gingiva" to "moderately severe periodontitis." Giemsa stains and an examination for micro-organisms were done on 2 sections from each case.

Fig. 1. (X20) Type of specimen usually obtained.

## FINDINGS

Case No. 1. Female. Age 42. Tooth No. 9. Labial crevice. Ulceration of apical one half of the crevicular surface. Parakeratosis of gingival surface. Active chronic inflammation both in the free and the attached gingiva with ingrowth of rete pegs and proliferation of epithelial rests of Malassez. Free gingival groove situated apically to bottom of pocket. No residual epithelial attachment at bottom of pocket in the area which had been scaled. (Fig. 2). Accumulation of debris on crevicular surface of pocket. Evidence of slight superficial injury to periodontal fibers at the bottom of the pocket. New bone formation on tip of alveolar crest.

In two areas where the crevicular surface appeared torn, micro-organisms (cocci) and extravascular red blood cells were observed within the traumatized tissues immediately beneath the crevicular surface.

Case No. 2. Male. Age 58. Tooth No. 9. Labial crevice. Ulceration of crevicular lining. Parakeratosis of gingival surface. Mild chronic inflammation. No residual epithelial attachment at bottom of crevice. (Fig. 3). Some periodontal fibers have been severed and cementoblasts have been removed from the surface of the tooth at the bottom of the crevice. The traumatized area was filled with coagulated blood. Bacteria and debris on crevicular surface, but no invasion of bacteria. A few bacteria observed within the connective tissue at site of surgical crushing in the apical end of the specimen.

Case No. 3. Male. Age 40. Tooth No. 12. Distobuccal crevice. Erosion and ulceration of crevicular surface. Parakeratosis of gingival surface. Active chronic inflammation extending into the periodontal membrane. Pronounced mucoid degeneration associated with the inflammation. No evidence of residual epithelial attachment in the area marked by the scaling. (Fig. 4). Some periodontal fibers have been severed at the bottom of the pocket and coagulated blood has filled this site of injury. Active resorption of alveolar crest.

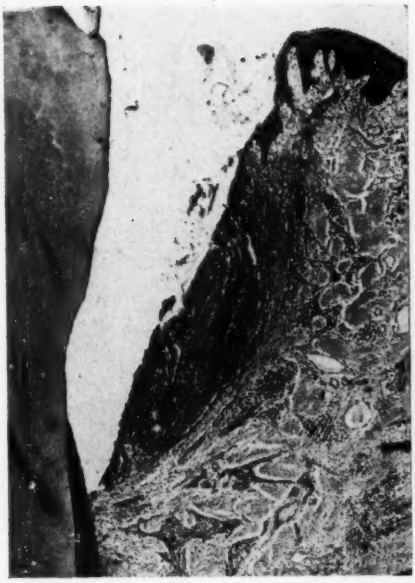

Fig. 2. (X45) No residual epithelial attachment. Debris and ulceration on crevicular surface. Demarkation for scaling not well shown in this picture.

Fig. 3. (X65) The defect produced in cementum by scaling is clearly shown. No residual epithelial attachment. Evidence of traumatic soft tissue injury from the scaling.

Fig. 4. (X231) The cementum has been fragmented during the scaling procedure. No residual epithelial attachment. Blood between the bottom of the crevicular lining and the surface of the tooth, indicating traumatic soft tissue injury from the scalipg.

Colonies of filiform organisms were observed on the surface of the crevicular lining. Some cocci were found in an area of hemorrhage and inflammation, ½ mm. beneath the crevicular surface.

Case No. 4. Male. Age 50. Tooth No. 28. Distobuccal crevice. Extensive crevicular ulceration. Parakeratosis of gingival surface. Severe chronic inflammation extending into the periosteum and the adjacent marrow spaces. Marked osteoclastic activity at alveolar crest. No residual epithelial attachment present at the bottom of the pocket. (Fig. 5). Evidence of rather severe traumatic injury from the scaling with cutting and tearing of periodontal fibers was seen mostly in association with fibers that were partially destroyed during the preceding course of inflammation. This area of injury was filled with debris (calculus, bacterial colonies, and fragments of cementum). Large colonies of bacteria were observed on the crevicular surface as well as superficial invasion of micro-organisms associated with coagulating blood in cracks of the crevicular lining. No bacterial invasion into

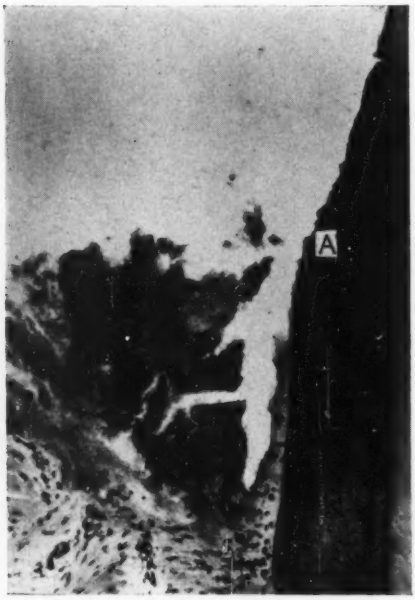


Fig. 5. (X308) No residual epithelial attachment. Debris in an area of injury from the scaling. The zone of injury extends apically to the mark produced by scaling on the tooth surface (A).

Fig. 6a. (X16) Defect in cementum and dentin demarkated the area of scaling on the surface of the tooth. Two gingival grooves.

living tissues was found.

Case No. 5. Female. Age 46. Tooth No. 23. Mesiolabial crevice. Small crevicular ulcerations. Parakeratosis and hyperkeratinization of gingival surface with evidence of marked stippling and two free gingival grooves. (Fig. 6a). Small gingival cyst. Marked squamous character of Malassez's epithelial rests (Fig. 6b). Chronic inflammation. No evidence of residual epithelial attachment in the scaled areas. Some specimens showed that periodontal fibers were cut at the bottom of pocket from the scaling (Fig. 6c). This area of injury was filled with coagulating blood and debris. New bone formation at alveolar crest.

Bacteria on crevicular surface. Some mononuclear cells contained phagocytized debris (possibly bacterial origin). No bacterial invasion found.

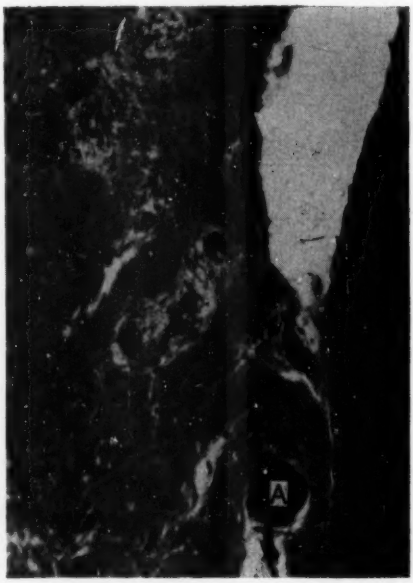


Fig. 6b. (X399) Large Malassez's epithelial rest (A). Tear in periodontal fibers at bottom of gingival sulcus. This area of injury appears partly filled with blood.

Fig. 6c. (X217) Severe injury at the bottom of the pocket. Debris and blood partially filling the crevice. Extravasation of blood in surrounding tissues.

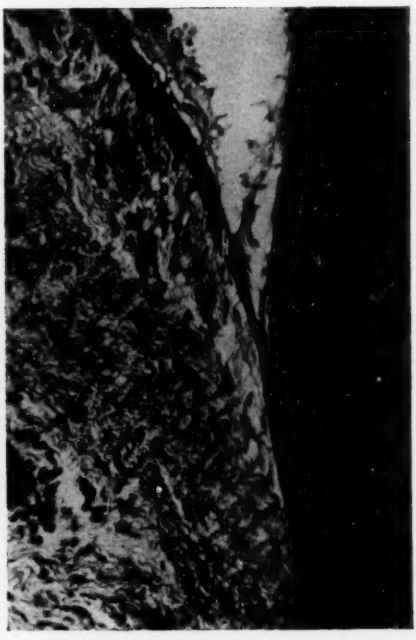

Fig. 7b. (X658) High magnification from 7a showing tear in the epithelial attachment with living epithelial cells attached to the cementum and blood within the split of the epithelium.

Fig. 7a. (X196) Thin residual epithelial attachment below marks produced by scaling (A).

Case No. 6. Female. Age 20. Tooth No. 20. Buccal crevice. Degenerative changes present in crevicular epithelium and partial split of rete pegs. Parakeratosis and hyperkeratinization of gingival surface. Acute passive congestion. Mild chronic inflammation. New bone formation at alveolar crest. In the area of deepest scaling (according to marks on the tooth) some trauma to periodontal fibers was observed and no residual epithelial attachment was present. However, in a closely adjacent area a slender projection of the epithelial attachment, 2 to 3 layers of cells in thickness, was seen apically to the reference mark for the scaling (Fig. 7a). This residual epithelial attachment showed evidence of a tear (Fig. 7b) and the presence of numerous red blood cells in the fissure of tear indicated that the tear had occurred before the fixation of the tissues.

Fig. 8. (X189) No residual epithelial attachment. Note cuticle (A) and blood between the cuticle and the crevicular epithelium indicating that this split was present before the fixation of the specimen.

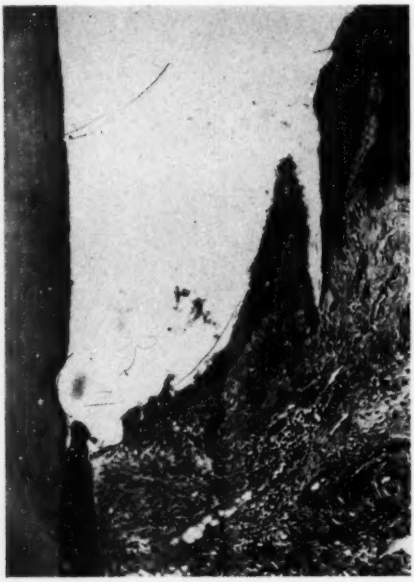

Fig. 9a. (X196) Split of crevicular rete peg and tear of epithelial attachment.

Fig. 9b. (X399) No residual epithelial attachment. Tear of a few connective tissue fibrils at the bottom of the crevice. The tear is partially filled with blood and extends into Malassez's epithelial rests.

An abundance of filiform and coccal organisms mixed with blood were observed in the gingival crevice. No invasion of organisms into living tissues.

Case No. 7. Male. Age 20. Tooth No. 27. Buccal crevice. Degeneration of crevicular epithelium. Split in rete peg of the crevicular lining (Fig. 8). Hyperkeratinization of gingival surface. Chronic inflammation. Resorption of alveolar crest and fibrosis of bone marrow. No evidence of residual epithelial attachment in area scaled, but a tear in residual epithelial attachment in adjacent areas. Small extravasation of blood into the tissues in immediate vicinity to marks from the scaling at the bottom of pocket. Abundant accumulations of coccal, filamented, and rod-shaped organisms mixed with desquamated epithelial debris and blood were observed in the gingival crevice. No bacterial invasion into living tissues.

Fig. 9c. (X826) Decalcified enamel (A). Primary and secondary enamel cuticle (B) with attached epithelial cells. Crevicular lining (C). Red blood cells present in the crevice indicating prefixation separation.

Case No. 8. Male. Age 20. Tooth No. 29. Mesiobuccal area. Clinically normal gingiva. Deep split of rete peg in otherwise unbroken crevicular epithelial lining (Fig. 9a). Hyperkeratinization of gingival surface. Mild chronic inflammation. New bone formation at alveolar crest. No residual epithelial attachment, but trauma from scaling has severed a few periodontal fibrils at the bottom of the pocket (Fig. 9b) and coagulating blood has partially filled this fissure of tear. Remains of enamel cuticle and a few attached epithelial cells were found on a small fragment of decalcified enamel (Fig. 9c).

Bacterial stains revealed mouth organisms only on the surface of the specimen.

Fig. 10. (X30) No residual epithelial attachment. Gingival microcysts.

Case No. 9. Male. Age 18. Tooth No. 9. Distobuccal crevice. Crevicular epithelial lining thin and completely missing in some areas (Fig. 10). Parakeratosis and hyperkeratinization of gingival surface. Two gingival microcysts in association with hyperplastic rete pegs. Mild chronic inflammation. No evidence of residual epithelial attachment at the bottom of the pocket. No bacterial invasion.

## EVALUATION AND CLINICAL SIGNIFICANCE OF FINDINGS

It appears from this material that thoroughly executed routine scaling of teeth with fine instruments will sever the epithelial attachment and the cut will extend into the adjacent connective tissue attachment. Only in one case was a slender epithelial projection (2 to 3 cells in thickness) observed that extended slightly apically to the scaling marks on the tooth. In the presence of severe inflammation and partial destruction of the collagen fibers, it was noted that the scaling tended to injure an area slightly apically to the bottom of

the epithelial attachment, and aggregations of surface granulation tissue and epithelial cells were loosened and sometimes removed from their normal site.

This observation is of great clinical significance since it will help to understand and explain the satisfactory results which have been obtained on the basis of seemingly different approaches to conservative periodontal therapy. It has been claimed,[3] but not wholly explained, that periodontal pockets could be eliminated and reattachment obtained without intentional removal of the epithelial attachment and the epithelial lining of the pocket. As brought out by Orban,[4] this seems theoretically impossible. However, it is evident from the present investigation that the epithelium in the bottom of periodontal pockets actually can be removed unintentionally by routine scaling thereby acting as subgingival curettage, and creating the biologic possibility for reattachment.

In recent publications it has been widely discussed as to how far below the bottom of the pocket one should remove soft tissues in order to assure elimination of the epithelial attachment.[1,2,8] A main argument against the use of subgingival curettage has been the often stressed possibility that one by this deliberate surgical or chemical extension of the pocket had to consider the risk of improper healing and loss of some periodontal attachment as a direct consequence of the therapy.[8]

To measure the depth of the epithelial attachment from sections is inadequate because it does not account for the often wavy surface of the bottom of the gingival crevice or pocket, but to assume that thorough scaling prior to subgingival curettage or gingivectomy will extend only to the degenerated cells on the surface of the epithelium at the epithelial attachment is a far greater error.

It is evident that the surface of the epithelial attachment, following oral prophylaxis, will not be at the same level as before the scaling, and that the measurements of the epithelial attachment indicated by Ritchey and Orban[8] do not apply to a case that has been prepared for subgingival curettage or gingivectomy by previous scaling.

On the basis of the presented findings there does not seem to be any rationale for removal of soft tissues below the bottom of the pocket during subgingival curettage or gingivectomy provided that a thorough scaling has preceded these operations.

The epithelial lining of the wall of the pocket was partially removed by the scaling in areas of severe inflammation and mainly in the apical one third of the pocket, but it is obvious from the presented photomicrographs that the epithelial lining of the pocket has to be deliberately removed in order to obtain maximum extent of reattachment following subgingival curettage. Ritchey and Orban[8] state, "Curettement of the soft tissue side of the pocket in expectation of an epithelial attachment should include the removal of *the entire pocket epithelium* . . . . . ." This statement should not be taken literally because it has been shown experimentally[6] that both connective tissue reattachment and new epithelial attachment may occur in the presence of numerous epithelial inclusions that remain of the previous lining of the pocket. An attempt to insure complete removal of very deep projections of rete pegs in the crevicular epithelium would lead to unwanted and unnecessarily extensive removal of soft tissues, a widened pocket, and delayed healing. Even the presence of a few remaining epithelial cells in small areas at the bottom of the epithelial attachment would not prevent reattachment from a blood clot in the pocket that was coronal to these remaining cells provided a fairly adequate removal of the epithelial lining of the crevice was accomplished.[6]

It was also interesting to note that the scaling tended to split deep rete pegs in the wall of the pocket as well as split the epithelial attachment. The extent of healing of these splits is not known, and it

will be investigated further. It is conceivable that a caustic drug such as phenol camphor would reach and more dependably destroy the epithelial cells within such fissures than would be possible by superficial surgical curettage.

There was a tendency for the scaling effects to extend apically to the epithelial attachment resulting in subepithelial injury. It is possible that this injury will deepen the pocket during the course of periodontal treatment especially in cases with severe active inflammation. The evidence of trauma is particularly significant because bacteria and debris commonly were observed in these areas mixed with the coagulating blood. The extension of scaling injury to Malassez's epithelial rests (Fig. 9b) may cause proliferation of these cells, and thereby be the source of a new epithelial attachment before connective tissue healing can take place, or before crevicular epithelium can reach the area. The practical implication of these findings should be to do a careful, but not necessarily a complete, scaling in severely inflammed pockets at the first sitting. The area should be rinsed thoroughly, and a blood clot allowed to form in the bottom of the pocket. Detailed scaling should be delayed for 7 to 10 days until the inflammation has subsided. During this period an epithelial lining of the crevice will form, and some organization and maturation of the subepithelial granulation tissue will take place so that definite resistance can be felt against instruments during the scaling procedure.

If subgingival curettage or gingivectomy has to be utilized for elimination of residual periodontal pockets, this should of course be done after the periodontal tissues have reached a maximal state of preoperative health in order to facilitate repair and regeneration.[7] Following the scaling, neither subgingival curettage nor gingivectomy should include tissues below the clinical bottom level of the pocket.

The significance of bacteria being present in the coagulating blood and in association with traumatized tissues can not be ascertained from this study. It may be assumed that they delay the process of healing. As to whether or not these bacteria are apt to invade further into the traumatized or the adjacent tissues can not be stated on basis of the present findings. That bacteria were observed on the root surfaces following extraction was in accord with what should be expected from operating in a non-sterile field.

Five gingival microcysts were incidental findings in serial sections of 16 specimens of the before described type. The free gingival groove, if present, did not necessarily correspond to the level of the bottom of the gingival crevice or pocket,[5] and in one case two gingival grooves were observed.

## CONCLUSIONS

1. Routine thorough scaling of teeth will tear and split the epithelial attachment, and commonly the scaling procedure will extend the tear into the connective tissue attachment.

2. Subgingival curettage or gingivectomy, if done following thorough scaling, should be extended only to the bottom of the clinical pocket at that time, because the epithelial attachment has already been severed by the previous scaling.

3. Scaling should be done with special care in areas of severe gingival inflammation to avoid deepening of the gingival crevice or the periodontal pocket.

4. The pocket should be thoroughly rinsed of debris, and a blood clot allowed to form following the scaling.

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# Biochemical and Biomechanical Aspects of the Resorption of Bone*

*by* FRANKLIN C. MCLEAN, PH.D., M.D.,** *Chicago, Illinois*

OUR knowledge of the morphologic aspects of the resorption of bone begins with a monograph by Koelliker,[1] one of the early great names in microscopic anatomy, who wrote a clear description of the process eighty years ago, in 1873, which still stands as a classic in the subject. And not only did Koeiliker describe resorption, with its role in the growth and reconstruction of bone. He also described and named the osteoclast, to which we must pay particular attention today; he found that bone mineral and bone matrix are absorbed simultaneously, a fact which has been repeatedly rediscovered in modern times; and he offered speculations concerning the mechanism of resorption to which relatively little has been added to this day. In many respects the picture of resorption is no clearer than it was when Koelliker left it; moreover much effort has had to be expended in clearing away misconceptions which were introduced by others attempting to improve upon his work.

In order to consider the details of resorption, it seems best to begin with the system which has to be resorbed, and then to proceed to the resources the organism has at its command to carry out the process. Resorption is, in essence, the putting into solution of a complicated structure, in such a fashion that it disappears, its end products entering the blood stream. Of the components of the structure, a small fraction is already in fluid form, and hence easily disposed of; the remainder is in solid form, for the most part insoluble or soluble with great difficulty in the aqueous fluids of the body. This is to say that, in order to resorb bone, it is necessary first that it be reduced to substances soluble in water, and second that these be transferred to the blood stream.

The interstitial substance of bone, which constitutes the major portion of the tissue, is the portion which now requires our attention. In ordinary histologic sections this interstitial substance appears to be homogeneous, and special technics, including staining and chemical methods, are required to bring out its characteristics. The intercellular portion of bone includes, besides

*Aided by grants from the Division of Research Grants, National Institutes of Health, Public Health Service; from the Josiah Macy, Jr. Foundation; and from the Wallace C. and Clara A. Abbott Memorial Fund of the University of Chicago. Read at 37th meeting of the A.A.P., Cleveland, Ohio, Sept. 25, 1953.

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water, two chief components; the organic framework, or matrix, and the inorganic part, the mineral of bone. The latter, commonly referred to as the bone salt, may form as much as 65 per cent of the dry, fat free weight of bone in adult life. The organic matrix itself also has two chief components. Of these the most prominent is fibrillar in nature, and is chemically a collagen, identical with or closely related to the collagens found in other connective tissues. Between the fibers are found a fluid, closely resembling the intercellular fluids of other tissues, and an amorphous "ground substance," whose most characteristic component is a glycoprotein (a protein which incorporates a carbohydrate within its structure) usually identified as chondroitin sulfate, or by the more general term, a mucopolysaccharide. The tissue fluid and the ground substance are considered to be coextensive and homogeneous, interconnected throughout, and with no clearly defined dividing line between the fluid and the solid state.

From the above it appears that one must account for the liquefaction of at least three substances, which together make up the main bulk of bone. These are: (a) the bone, in 1924 offered the opinion that as collagen; and (c) an amorphous ground substance, especially characterized by its content of a polysaccharide. The latter gives us the least difficulty, since it is so closely related to the interstitial fluid, and apparently can be made soluble in water by a change in its state of polymerization. Such changes have, in fact, been described,[2] and are accompanied by an increase in the concentration of mucopolysaccharide in the blood.

Collagen, even at the hydrogen ion concentration of the fluids of the body, can be rendered soluble rather readily. Collagen from certain sources, such as the tendons of the rat's tail, or the swim-bladder of fishes, will dissolve in dilute acid. This, of course, is not true of the collagen of bone, since it withstands decalcification in a strongly acid solution. When boiled in water, collagen yields glue. At the temperature and the hydrogen ion concentration of the fluids of the body, it can be made soluble only by digesting or disintegrating the protein which is collagen. This can be accomplished in the test tube by various proteolytic enzymes, including pepsin, but peculiarly enough, not by trypsin. In the body an enzyme known as collagenase, is everywhere present, and mechanisms for its activation exist.

Up until rather recently one would have had to say that solution of the bone mineral could occur rapidly and completely only in an acid medium, although some portions of the mineral are more readily yielded up to the body fluids, especially when the latter are lacking in these elements. This situation has been radically changed, however, by the introduction of a group of compounds, known as chelating agents, which have the ability to form firmly bound complexes with such substances as calcium. Without going further into this subject, it may be said that it is now possible to decalcify bones and teeth outside of the body by immersion in solutions of such agents, even when such solutions are neutral or strongly alkaline.[3] One may therefore safely assume that solution of the bone salt may occur whenever another substance, having a stronger affinity for calcium, is present in the solution. This removes one of the obstacles in forming an hypothesis for the resorption of bone, since such an hypothesis may now account for solution of bone salt, collagen, and ground substance, all at the hydrogen ion concentration of the body fluids.

From the time of Koelliker it has been agreed that both the organic and inorganic components of bone are absorbed together, leaving smooth surfaces at the loci of resorption. Assuming that there is continuously applied to a surface of bone a solution which will depolymerize mucopolysaccharides, digest collagen, and hold calcium in a firm combination, then one has the basis for a working hypothesis for the mechanism of the resorption of bone, requiring only certain enzyme systems and an organic

substance to combine with calcium. Let it be emphasized at once that this is only a working hypothesis. It does not conflict with any known facts, but positive evidence that the hypothesis really represents the facts in the case is lacking. I am not assuming the presence of any known chelating agent; I am merely pointing out that for the first time it is possible to assume solution of the bone mineral at the hydrogen ion concentration of the fluids of the body.

If we continue with our idea of a solution being continuously applied to a surface of bone, we are on firmer ground. Koelliker attributed this function to the osteoclast, eighty years ago, and the circumstantial evidence is to the effect that the osteoclast does, in fact, bring about erosion by elaboration of a secretion which acts at the surface of bone.

The osteoclast is a multinucleated giant cell, found in the marrow cavity, in close relationship with bone undergoing resorption. It varies greatly in size and in the number of nuclei. Its pale-staining cytoplasm is often foamy; it frequently has branching processes with serrated edges. While its origin has been in dispute, I accept the view that it commonly arises by the fusion of a number of osteoblasts, and may also incorporate osteocytes liberated by the bone being resorbed. In accordance with this view the osteoblast, associated with the formation of bone; the osteocyte, surrounded by bone and related to its maintenance in a living state; and the osteoclast, involved in the resorption of bone, all represent different morphologic and functional expressions of cells arising from a common ancestry. They are capable of transformation,[4] one to the other, in response to specific stimuli. This view does not exclude the origin of the osteoclast directly from the stromal cells of the bone marrow—the common source of the cells intimately related to bone.

Koelliker, in 1873, concluded that the osteoclast erodes bone by chemical means, without specifying further the nature of the chemical action required. Later, others[5] added the supposition that the action was a combination of that of an acid with that of proteolytic enzymes, but as we have noted, the necessity for the presence of acid has been a difficult stumbling block in the formulation of a theory of resorption. Koelliker[6] himself drew an analogy with the destructive effect of fungi on hard tissues, such as scales of fishes and the shells of mussels, and others have called attention to the erosion of limestone by vines adhering to it. Other similar phenomena are known, but none provides a satisfactory analogue for the mode of action of the osteoclast.

As the process of phagocytosis has become increasingly well understood in other connections, it has been entirely logical to assume that osteoclasts resorb bone by phagocytosis, and to attempt to find evidence supporting this view. The osteoclast is a giant cell, resembling in some respects other giant cells known to have phagocytic capabilities, and if it could be shown to ingest cellular debris and bone mineral, the case would be complete. Unfortunately, at least for this theory, it has not been possible to demonstrate that the osteoclast ever does ingest such debris or mineral, even under conditions which furnish abundant instances of phagocytosis by other cells in the bone marrow in the immediate vicinity of bone undergoing resorption.[7] For the present, then, I am excluding the possibility that resorption of bone ever occurs by osteoclastic phagocytosis.

Before returning to our alternate hypothesis, we may pause to inquire whether there is sufficient evidence to implicate the osteoclast in the resorption process at all. There is the possibility that this multinucleated giant cell is simply a byproduct of resorption, being formed by aggregation of osteoblasts and osteocytes liberated by resorption effected by other means. A recent exhaustive review[8] on osteoclasts states: "There is no direct evidence that osteoclasts erode bone, but their constant occurrence in zones where absorption is taking place, together with the associated

histological picture and especially their striated border, suggest that their presence is more than incidental." I concur in this statement, and shall proceed under the assumption that osteoclasts do bring about resorption of bone, by some such process as that developed above.

Even if the view that osteoclasts resorb bone is accepted, we still have before us the very important subject of the control of this process, which certainly does not occur spontaneously or at random. Resorption of bone, accompanied by the presence of osteoclasts, begins with the very earliest stages of ossification in the embryo, and continues throughout life, although there are marked differences in the location and the rapidity of resorption, according to the physiological, functional, and structural needs of the moment. We must look, therefore, for the influences which evoke osteoclastic activity, and these may be found either generally, throughout the organism, or locally, in circumscribed locations.

### HUMORAL FACTORS

While the control of local resorption is more closely related to the subject of this paper, some attention to the general or humoral factors which may determine the occurrence of resorption will be of interest, considering that even when under humoral control there are differences in the responsiveness of particular bones, or particular locations in bones, to the stimulus carried in the blood, which reaches every part of the body.

Years ago, histologists were compelled to study resorption as it occurs naturally in the organism. For the most part this meant following a very slow course of events, with little opportunity to observe the intermediate stages. With this limitation, together with the technical limitations under which they worked, it is remarkable that they were able to comprehend and to describe such phenomena as resorption in terms that require very little modification. Newer methods of producing generalized rapid resorption of bone have made the subject more accessible to study, and have added to the details, if not fundamentals, of the processes. Observations made under such conditions may be briefly reviewed.

Of these, hyperparathyroidism occurs clinically, and extreme cases are notable for rapid resorption of bone, accompanied by large numbers of osteoclasts. The condition is, however, rather rare, and obviously not subject to experimental control. With the isolation of an extract from the parathyroid glands, and its being made available for clinical and experimental use, there have been many studies of hyperparathyroidism in a variety of animals. In all such studies the appearance of large numbers of osteoclasts has been a prominent feature of the histologic picture, in addition to the manifest signs of destruction of bone, but the mechanism of resorption has so far escaped elucidation. Cell transformations, however, have been frequently observed, and have added strength to the belief above stated that osteoclasts may arise from other cells characteristic of bone, and may return to their former states, or may be transformed to reticular cells in the bone marrow.[4] Moreover, these studies have given no evidence that osteoclasts participate in phagocytosis, even in the presence of the debris and bone mineral resulting from the necrosing action of toxic doses of the hormone.

Another situation in which resorption occurs on a widespread scale is exhibited by birds during the egg-laying cycle,[9] and can be reproduced experimentally even in male or castrate birds,[10] by the administration of estrogens. The pigeon has a short cycle and as a rule, lays only two eggs. During the preovulatory stage, the bird develops a secondary system of spongy bone in the marrow cavities of the long bones. When the first egg passes down the oviduct into the shell gland, the stage of bone formation is rapidly replaced by destruction of bone, resulting in the liberation of calcium used in the formation of the egg shell. During the stage of resorption of

the medullary bone the histologic appearance, and the observed transformations of cell types, closely resemble those seen in hyperparathyroidism, with the important exception that resorption in the bird is not accompanied by the manifestations of toxic action seen after administration of parathyroid extract.

During the egg-laying cycle the serum calcium of the bird is greatly elevated, and this elevation is accompanied by the presence of a phosphoprotein, called serum vitellin, which appears to have a special affinity for calcium, and to be responsible for its transport in the blood, from the medullary bone to the shell gland. From observations made some years ago,[11] it seems clear that the excess calcium in the plasma is carried in a poorly ionized form, which does not participate in the equilibrium determining the concentration of ionized calcium, and the presumption is that this calcium is in combination with the serum vitellin. This combination is similar to the complex formation by the chelating agents just described, and perhaps one may speak of "physiologic chelation" as occurring in the bird during the egg-laying cycle. It is tempting to relate the process, and the production of a chelating agent, to the osteoclast. This would complete our working hypothesis of the essential nature of resorption, but it would be premature to assume that the serum vitellin which appears in the blood of birds, and assists in the transport of calcium, is indeed the same substance that enables the osteoclast to erode bone. To all of this there must be added the statement that while it is clear that estrogen brings about, in some unknown fashion, formation of new medullary bone in the bird, we have no clue as to the mechanism of the sudden reversal of the process and the evocation of widespread resorption, for the most part limited to the secondary medullary bone, leaving the skeletal system itself undamaged.

## BIOMECHANICAL FACTORS IN BONE RESORPTION

The influences of local factors in bone resorption are most easily seen in the growth of bone, during which certain areas, such as those in the neighborhood of the epiphyses of the long bones, are singled out for reconstruction. Such reconstruction invariably includes a considerable amount of osteoclastic resorption, followed by appositional bone formation, with the result that the size and shape of the bone progress toward the adult state. Organization and regulation of these phenomena, affecting most of the bones of the body simultaneously, is a part of the overall growth process, only imperfectly understood. Some of the factors, at least, are local, especially those related to the strains and stresses to which a particular bone is exposed, and it is these to which we must give special consideration.

It has been said[12] that the "structure (of a bone) even to minute details, is beautifully adapted to the performance of its supporting function with the least expenditure of material and with the least weight." This implies some adaptation, and adaptation can hardly be carried out without resorption. Moreover, we have striking examples of adaptation when bone is resorbed when subjected to pressure by expanding tooth germs, by malocclusing teeth, or by expanding tumors or aneurysms. Discussion of the details of resorption of alveolar bone is not in the scope of this paper; my task is to attempt to clarify the means by which resorption is brought about under the influence of mechanical stimuli. I shall have only limited success in this endeavor.

Pommer,[13] one of the outstanding figures in microscopic anatomy, who made many contributions to the histophysiology of bone, in 1924, offered the opinion that pressure on bone stimulates osteoclastic activity. This is certainly an oversimplification, since it does not account for any of the stages intervening between cause and effect.

Hancox, in his 1949 review, expresses the idea "that osteoclast-provoking stimuli cause some primary change in the consti-

tution of the bone itself, either in its salt, ground substance, or fibrils, which results in the liberation of a substance, akin perhaps to histamine, under the influence of which osteoclasts form." After coming to the conclusion that such a change must be in the organic matrix, he continues: "ground substance seems a more likely choice than the fibrils, for several reasons," but he ends by saying that "obviously a great deal more information is needed before we can decide whether the stimulus to osteoclast formation emanates from the bone."

This is still a very incomplete account of the manner in which pressure on bone, or internal stresses and strains, can lead to osteoclastic activity and hence to resorption of bone, but it does reflect the current uncertainty on the subject. It modifies the earlier view of Pommer only in that it assumes that mechanical stimuli induce the ground substance of bone to elaborate a substance which, by a local effect, brings about osteoclastic activity. This may be satisfactory as a working hypothesis, but neither the reviewer nor I can offer tangible evidence in its support at this time.

Except for the shedding of deciduous teeth, which is accompanied by marked osteoclastic activity, resorptive processes are entirely lacking in the development and growth of the tooth. It has been shown[14] that with this exception enamel, dentin and cementum are exempt from the processes we have been describing, even when the alveolar bone is being markedly affected by large doses of the parathyroid hormone. What I have had to say refers to bone only, but the principles under discussion are valid for alveolar bone, since many of the observations have either been made or confirmed on bone from this source.

I would like to summarize what we know today about the resorption of bone. It is mediated mainly, but perhaps not exclusively, by osteoclasts. Osteoclastic resorption, accompanied by large numbers of these cells, is seen in all animals under the influence of the parathyroid hormone. It is prominent in birds when mobilization of calcium for the egg shell is in process. It occurs regularly, under both normal and pathologic conditions, under the influence of local mechanical stimuli.

Furthermore, osteoclasts dissolve organic and inorganic material of the interstitial substance of bone simultaneously. For the solution of organic materials they provide the needed enzymes. We do not yet know how they dissolve inorganic salts, but I have assumed that instead of acid they make use of compounds which form soluble complexes with calcium.

Future work should be channeled in a direction to include the manner by which chemical and mechanical stimuli bring about increased osteoclastic activity, and whether or not the formation of complexes with calcium serves for the solution of the bone salt. If the theory of chelation can be proved, then identification of these complexes will be a problem of major importance.

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## Discussion of Dr. Franklin C. McLean's Paper

*by* J. P. WEINMANN, *Chicago, Illinois*

I SHOULD like to emphasize that bone removal is a cellular and not a humoral process, a process accomplished by the action of osteoclasts. Dr. McLean quoted Hancox who is of the opinion that the constant and simultaneous presence of osteoclasts in areas of bone removal is a good indication of their action. However, others have argued, as Leriche and Pollicard did, that the osteoclasts are the result of bone removal and not its cause. Against such an interpretation speaks an observation on the *ia* rat by Bhaskar et al (Am. J. Anat. 86:439-478, 1950, and J. Dent. Res. 31:257-270, 1952). These animals are characterized by a failure of bone resorption which results in a general osteosclerosis. Despite their lack of bone removal, osteoclasts are present in great numbers in areas where bone resorption occurs in normal animals.

I was especially pleased that Dr. McLean considered the possibility of an chelating agent playing an important part in making the mineral salts, liberated by the action of osteoclasts, soluble so that they can be carried away by the blood stream or by the tissue fluids. Only to stress our agreement on this point, I want to mention that Dr. Sicher and I included independently such a possibility in the just finished revision of our text "Bone and Bones."

On one point I cannot agree with Dr. McLean, namely, on the histogenesis of the osteoclasts. Dr. McLean asserts that one of the cells from which osteoclasts may differentiate are the osteocytes liberated by the action of osteoclasts. The observations on which this statement is based are, in my opinion, not convincing. It seems improbable that such highly differentiated cells should be able to differentiate to an entirely new function. It is correct, and Dr. Sicher and I have observed it also, that liberated osteocytes or better, their degenerated nuclei, became incorporated into osteoclasts by their phagocytotic ability. There is, however, clear evidence, that osteoclasts differentiate from undifferentiated mesenchymal cells of the connective tissue or reticular cells of the bone marrow. Bhaskar observed that proliferation of reticular cells follows immediately an injection of parathyroid hormone into *ia* rats. I should like to recall also the fact that osteoclasts are active likewise in the resorption of hard substances, which do not contain osteocytes, as for example, transplanted boiled bone or transplanted ivory or dentin during the shedding of teeth. In cases of internal resorption of teeth where the dentin is removed from its pulpal surface, osteoclasts without doubt differentiate from pulpal cells, fibroblasts or undifferentiated mesenchymal cells.

# Some Observations on the Cleansing Effect of Nylon and Bristle Tooth Brushes*

*by* M. Kiplinger Hine, Jr., *Oberlin, Ohio*
Carl Wachtl, *Detroit, Michigan,*
L. S. Fosdick, *Chicago, Illinois*

ALTHOUGH the practice of oral hygiene procedures does produce certain important cosmetic and esthetic effects, its principal function is to increase the resistance of the gingivae to disease and to assist in the prevention of dental caries. One of the most useful tools in the practice of oral hygiene is the tooth brush. It stimulates the gingivae and removes the debris, foodstuffs, and dental plaque from the tooth surface.

There is a wealth of literature on the subject of the proper use and design of the tooth brush. It is recognized that a tooth brush should be so used and designed that it will effectively clean the surfaces of the teeth and stimulate the soft tissues. In spite of the fact that the objectives of its use are clearly stated and the methods of use have been intensively studied, there is little accurate information concerning the actual cleansing effect of this important adjunct to oral health. There are no recognized standards for acceptable design, bristle quality, type of bristle, or brush efficiency. The dental profession has developed standards for a large portion of the products used or recommended by the dentist; but in the cases of the two most widely used items—the tooth brush and the dentifrice—no standards have been developed to guide the dentist in making recommendations nor to help the manufacturer in the production of his products.

For a long time tooth brushes were stapled exclusively with hog bristle. This material is not uniform in texture, size, flexibility, nor wearing properties. In addition, it is expensive and at times, especially during the past war, good quality has been difficult to obtain. Since the introduction of nylon filaments for tooth brushes, their use has steadily increased until a large percentage of all tooth brushes used in the United States are made with nylon. This change was primarily based upon convenience and economic factors. The size, flexibility, texture, and physical properties of the synthetic material can be accurately controlled, and a uniform product can be readily maintained. The nylon filament brush is less expensive and in general much longer lasting than the natural bristle brush.

Hence, the change to nylon filament brushes was made and they were offered to the public without the sanction of the dentist or the public, and with little or no accurate information concerning their cleansing efficiency or effect on soft tissues. It is the opinion of many dentists that natural bristle brushes are superior for the purposes intended and they continue to recommend them. The preference is usually based upon subjective clinical observation of the relative merits of the two types of tufts rather than upon any absolute standards based upon laboratory tests.

The fact that no standards are available for tooth brushes is probably not due to a lack of interest on the part of either the profession or the industry but may be primarily attributed to inadequate knowledge of tests or procedures.

The actual effect of the tooth brush on the gingiva and teeth is probably as much

*The tests reported here were made at Northwestern University, and in the laboratories of Lactona, Inc.

The assistance of Mr. Frederickson of Lactona, Incorporated is gratefully acknowledged. All of the equipment and supplies used in these experiments were furnished by Lactona, Incorporated.

a function of the method of use as of the type of bristle design and size. It is quite possible that a very inefficient brush may do a satisfactory job if used properly or long enough, while a very efficient brush may do a very poor job if not properly used. But there should be methods whereby the cleansing effect or efficiency of the brush itself could be determined. This paper is a summary of a number of attempts to devise methods of testing under vigorously controlled conditions.

The studies described here were undertaken to determine differences, if any, in the efficiency of cleansing power on hard, smooth surfaces. The test specimens were in all cases either nylon filament or natural bristle brushes. In each case the brushes were identical in design; the only difference was the bristle or nylon filament stapled to the brush.

It should be noted that these investigations are not clinical studies. The objectives of the study were to gather physical data on the different materials in an attempt to find some useful procedure which may be used in a laboratory for assessing the qualities of a brush in regard to the primary purpose of its function. It is hoped that these procedures and data may lead to ways of testing brushes for the purpose of evaluating them in regard to effectiveness. It should be emphasized that, although these studies are purely *in vitro,* the clinical aspects of the problem are, of course, of paramount importance; and before any practical conclusions may be drawn, these must be taken into careful consideration.

Insofar as the cleansing of the teeth involves the removal of masses of varying consistencies from the hard tooth surfaces, all of the following experiments were designed to determine the relative amounts of various materials that could be removed by standard brushing procedures, to measure physically the drag or friction of the bristles or filaments, or to observe visually the tracks of the brush when moved over a surface. It was thought that one or more of these procedures may prove of value in assessing the value of the brush.

## EXPERIMENTAL

In order to compare the brushes stapled with nylon filament with brushes stapled with hog bristles it was considered that the size, shape, and design of the two brushes, including the number of tufts, size of filament, and trim, should be identical. The only variable allowed was the material with which the brush was stapled. The tuft in one case consisted of nylon filaments and in the other case, hog bristle. In each case careful records of the size, number, and length of the filaments in tuft were recorded and similar data, although not so accurate, were obtained for the bristle. Brushes as nearly identical as possible were prepared and furnished by Lactona Incorporated.

It was thought that in addition to having brushes as nearly alike as possible the mechanism of use of each brush should be the same. For this purpose a holder was devised to which two brushes could be attached. By the use of this holder each of the two brushes could be subjected to identical treatment in regard to movement and degree of pressure exerted. Thus, the nylon brush and the natural bristle brush could be subjected to identical treatment and the results could be compared. The device could be attached to a mechanical brushing machine or the brushing could be performed by hand. The stress upon the bristles could be varied by the addition or subtraction of brass weights, as shown in Fig. I. The various procedures were tried and the results were compared.

(1) Photographic film, standard, 5″x7″, was selected as the material to be brushed because of the uniform thickness of the film. The film was exposed to light and developed, yielding a gelatin film with colloidal metallic silver evenly dispersed throughout the mass. Brushing experiments were performed with these films both with and without first hardening the gelatin

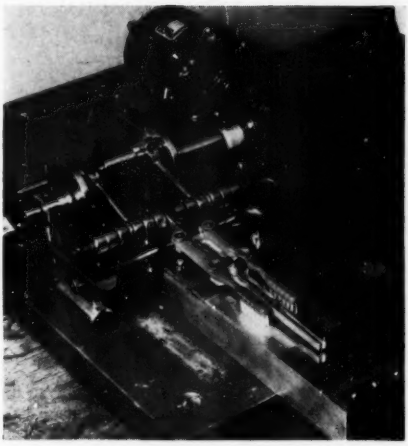

Figure 1.

layer with formaldehyde. The brushing was also tried both with and without abrasive. The abrasive found to be the most satisfactory was a slurry of glycerol and pumice powder. If water slurries were used the gelatin layer was often softened too much and sharp bristles would cut through the gelatin layer.

The loss of gelatin was measured both gravimetrically and by means of the increase in transmission of light. The gravimetric procedure was the more accurate, although the change in light transmission was satisfactory until part of the film was worn through, which materially decreased the accuracy.

It was found that in general, whether the brushing was done by machine or by hand, the bristle brush removed more of the gelatin layer than did the nylon filament brush. This was true whether a light or heavy stroke was used. A study of the tufts of the used brush indicated that natural bristle had a tendency to flag or split, while the nylon had a tendency to wear smooth.

(2) Weighed lead plates were mechanically brushed with both types of brushes, using toothpaste and water as a slurry. After brushing, the plates were checked for weight loss, and the weight lost was taken as a measure of the cleansing efficiency of the brush. The relative efficiency of natural bristle and nylon was compared: the natural bristle appeared to be about 700 per cent more efficient than nylon. However, the trim loss of the natural bristle was much greater than the nylon; the shortened trim of the brush made with natural bristle would add stiffness and this, in turn, might account for some of the difference in weight loss.

(3) Glass slides were painted with several coats of a high gloss enamel, which was dried until only the surface layers hardened. The enamel was then brushed off mechanically, using both types of brush. The natural bristle brush removed all the paint before the nylon brush had worn through the surface layer.

(4) The silvered backs of standard mirrors were brushed mechanically, using toothpaste and water as a slurry, with both kinds of brushes. At the end of 3,000 strokes the mirror being brushed with a natural bristle brush showed definite wear, while the surface being brushed with nylon remained unchanged. After 4,000 strokes the natural bristle brush had worn completely through the backing, while the surface under the nylon brush had just begun to show wear.

(5) Glass microscope slides of standard size were coated evenly with photographers' black oil paint, a highly viscous substance. This was allowed to dry for 24 hours and then brushed, using the two-brush holder. (See Fig. 1.) At the end of 300 strokes the natural bristle brush had removed the paint from a large area of the slide, while the nylon brush had just broken through the slightly tougher top layer. Upon examination with a magnifying glass, it was observed that the natural bristle brush had deposited all of the material which it removed in the form of tiny flakes at the ends of the stroke, while the nylon brush had taken up all that it removed in the filaments themselves. The nylon brush

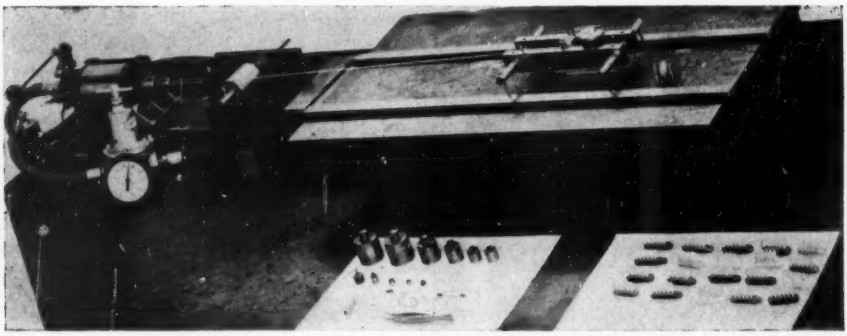

Figure 2.

seemed to have a tendency to push and disarrange the material without removing it, while the brush with natural bristles pulled it off cleanly.

(6) Wear tests were made on acetate sheet. Five sets of four brushes each were prepared. Each set included two matched, hard brushes (one natural, one nylon) and two matched medium brushes (one natural, one nylon). These were chosen because they had comparable stiffness. Clear acetate sheet was used for the testing surface. At the end of 500 strokes the plates and brushes were examined. Trim loss was negligible. The differences between the plates were not striking. However, the following conclusions seem justified: (a) In most cases the natural bristle brushes removed more acetate than did the nylon brushes. (b) The natural bristle brushes removed the acetate more evenly, without deep scratches or variations from point to point on the acetate. (c) Attempts to compare the marks on the acetate microscopically yielded nothing conclusive.

(7) Several glass slides were coated with beeswax and two other harder waxes. These were mechanically brushed for short periods, using the two-brush holder. High power microscopic examination revealed that the nylon filaments had cut away the wax; the grooves were deep, clean, V-shaped, and the sides were smooth. The natural bristle had removed much more material; the grooves were shaped like trenches, straight-sided and rough. This suggests that the nylon filaments displace material, while bristle pulls it away.

(8) Small pieces of 0.014 acetate sheet were cemented to glass slides and covered with acetone, which penetrates the acetate and softens it to an almost jelly-like consistency. A single strand of bristle or nylon filament was then mounted in a pin vise and drawn across the softened acetate, making a deep, wide track. As the acetone evaporated the acetate rehardened, leaving a solid track to examine. Again, this test seemed to indicate that nylon displaces while bristle pulls away.

(9) Gelatin films were prepared by swelling photographic plates in water and pulling brushes through the resulting jelly-like film. Two sets of identical brushes were used. One series had standard trim; in the other series all of the nylon brushes were sanded to round off the ends. Photomicrographs were then made of the tracks made by the brushes. No conclusions could be drawn from this study, although the tracks made in the two series were not identical.

(10) Impressions of both nylon and natural bristle ends were made by pressing the bristles into softened "Fax Film." These were shadowed with chromium and photographed under magnification. While the character of the ends differed, no state-

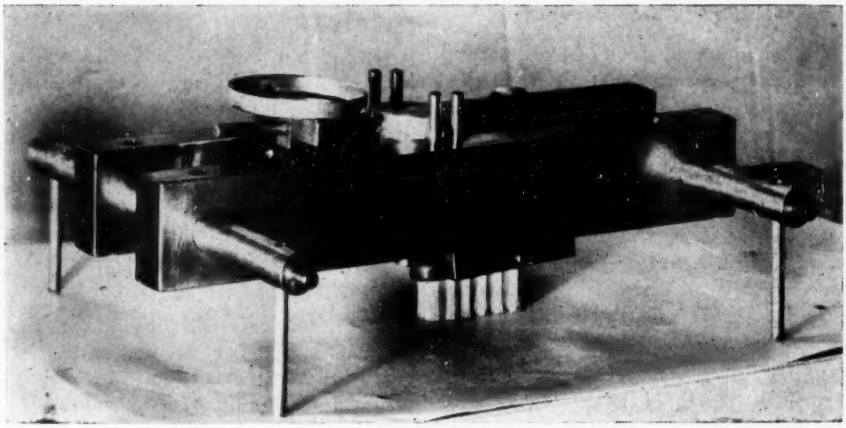

Figure 3.

ments could be made except that the natural bristle ends seemed to have a more roughly textured surface than did the nylon. It was suggested that this roughness of the bristle ends might have bearing on the cleansing efficiency of the bristles.

(11) Photographic paper was used to record brush tracks by dipping brushes into fixing solution and drawing them across the surface. The brush holder made it possible to use the same pressure on each brush. There was better coverage by the natural bristles and they seemed to rub the surface more evenly than the nylon. The two rows of the nylon brush sometimes made two separate tracks rather than closing together to cover the surface, as did the bristle brush.

(12) Photomicrographs were taken of samples of bristle and nylon from three used brushes. These were examined for differences caused by use. The natural bristle ends split and flagged, making a greater number of small contact surfaces as the bristle wore down. Nylon filaments, on the other hand, showed a grinding wear, keeping a smooth and rounded end.

(13) Tests were made to determine friction drag of a toothbrush across a baked enamel tray. Force was applied by a weight and pulley system until the brush began to move evenly. The weight in grams was used as a measure of the grip of the brush on the surface. In this test the natural bristle brush appeared to have more grip on a surface than did an identically designed and textured nylon brush. To test this further, apparatus was designed and assembled to pull brush heads, both wet and dry, or single strands of bristle or nylon, across a ground glass surface under completely controlled conditions. (See Figs. 2 and 3.) Dry brushes in three styles (12 knot, 18 knot and multitufted) showed natural bristle to exert up to 100 per cent more drag than nylon. Wet brushes showed the natural bristle to have from 400 to 600 per cent more drag than nylon. Tests with single strands yielded results essentially the same, except that the differences were not quite so great. It was possible to duplicate the above experiment at will.

(14) Several miscellaneous experiments were tried with beeswax, carbon paper, combinations of acetate, etc., but no definite conclusions could be made from them so they are not reported here.

DISCUSSION AND SUMMARY

The cleansing efficiency of tooth brushes is extremely difficult to measure, but it may be possible to measure certain factors so that comparative data may be indicative of relative efficiency. The cleansing of the teeth by brushing entails the removal of debris from rather smooth, hard surfaces. Many of the above tests indicate that the natural bristle seems to facilitate the removal of soft or hard debris much better than does the more durable nylon filament.

Of the many tests described above, probably the most significant and readily duplicated is a measure of the drag. It is quite possible that this could be standardized as drag per unit area of bristle surface with constant weight, and these data may serve as a standard for the profession and manufacturers.

A study of the results of these tests indicates:

1. Nylon displaces or pushes aside soft, homogonous material, such as emulsion on photographic film and heavy oil paint; natural bristle apparently grips and pulls off the soft material.

2. During use, nylon filament apparently wears smooth and glides over the test surface, while the bristle continues to grip the surface.

3. Under comparable conditions the quantity of material removed by natural bristle brushes was usually notably greater than the amount removed by nylon filaments.

4. Although final conclusions cannot be made on the basis of these preliminary studies, the experiments suggest that the natural bristle brush cleanses more efficiently than one with nylon filaments.

## DENTAL AWARD TO DR. COOLIDGE

Edgar D. Coolidge, D.D.S., Chicago, Illinois, was named winner of the Loyola Dental School's first annual award to a distinguished dental alumni. Presentation of the award scroll was made at the banquet which closed the annual dental homecoming on April 28.

Internationally known in his profession, Dr. Coolidge has been honored many times during his forty-eight year career. In 1947 he received the Callahan Award, a top honor which is given annually to the man who has made a distinguished contribution to dental science. He has an impressive record of publications also—having authored more than 500 professional papers and a textbook on Clinical Pathology. Long active in dental organizations, he has been president of both the Chicago Dental Society and the Illinois Dental Association.

Dr. Coolidge has actually served "two hitches" on the Loyola dental faculty. He was a professor of operative dentistry following his graduation until 1913 when he joined the staff of the University of Illinois. In 1927 he came back to Loyola, remaining at the Dental School until his retirement in 1947. In recognition of his service to the University, Dr. Coolidge was given an honorary doctor of laws degree at the March '48 convocation. —*From the Loyola Alumnus, May 1954.*

# Where Gingivectomy Fails

*by* A. Bryan Wade, B.Ch.D., F.D.S.R.C.S.,* *London, England*

Surgical resection of gingival tissue has been practised in some form since 1757 when Bourdet described the way in which he made a V-shaped incision between the teeth to the bottom of the pocket (Black, 1936). The work of Ward (1928) in the United States and Stones (1932a and b) and Fish (1944) in Britain has brought about a greater appreciation of the value of this operation, now known as gingivectomy. It is nowadays performed extensively, but the results do not appear to be uniformly satisfactory.

The reasons for the failures may be:

1. choice of unsuitable cases,
2. failure to map out the pocket depths,
3. commencing or terminating the incision in a papilla,
4. cutting with insufficient obliquity,
5. failure to eliminate pockets,
6. leaving tags,
7. inaccessible interdental spaces,
8. insufficient packing,
9. loose packs,
10. loss of packs,
11. failure to prescribe stimulators,
12. failure to use stimulators,
13. non-elimination of aetiological factors,
14. non-elimination of predisposing factors,
15. failure to complete treatment.

## Choice of Unsuitable Cases

The mere presence of a periodontal pocket is not in itself an indication that success will be achieved by performing a gingivectomy.

A periodontal pocket is defined as a pathologically deepened gingival crevice (Cross and Wade, 1953). This deepening may, of course, be produced by a destructive type of lesion, by a proliferative one or by a combination of both. When the pocket is formed by destruction of the supporting tissues it is said to be a *true* pocket, whilst it is called a *false* pocket when there is deepening of the gingival crevice due to an increase in the height of the free gingiva without tissue destruction and subsequent apical downgrowth of the epithelial attachment. These are unsatisfactory terms, but they serve a useful purpose. If a pocket is both true and false, Christensen (1944) described it as *combined*, and that term will be used here.

A true pocket may have its base coronal to the alveolar crest, in which case the outer wall is entirely soft tissue and so it may be called a *gingival* pocket. On the other hand the base may be apical to the alveolar crest, and the pocket said to be an *intrabony* one. A false pocket is always of the gingival variety, whilst a combined pocket can be either type.

This classification of pockets is important for failure to identify correctly the exact type may lead one to perform a gingivectomy on an unsuitable case. Normally an intrabony pocket cannot be treated adequately by gingivectomy alone. Excision of the soft tissue wall of the pocket will only produce partial elimination, and that part of the pocket which is deep to the alveolar crest will remain (Fig. 1). Glickman (1953) has recently suggested a modified gingivectomy technique using a vertical incision for the elimination of broad intrabony pockets.

He (Glickman, 1950) has also classified gingival enlargement. In five of his groups, which are named non-inflammatory hyperplastic, combined, conditioned and developmental, only a transitory improvement will be achieved by deleting the accompanying pockets if the underlying factors cannot be

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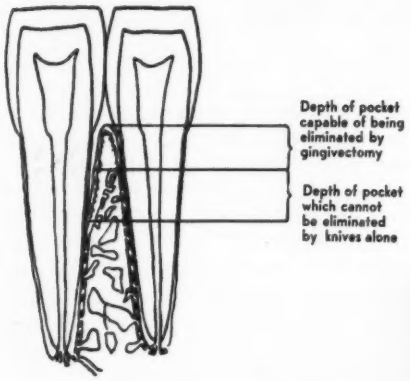
Depth of pocket capable of being eliminated by gingivectomy
Depth of pocket which cannot be eliminated by knives alone

Fig. 1. A diagrammatic representation showing how a residual pocket is left if an intrabony pocket is treated by gingivectomy only.

identified or eliminated. For example the gingival enlargement which is sometimes associated with puberty will repeatedly recur after excision of the gingival tissue until maturity is reached (Fig. 2). It may well be that a minimal amount of irritation is necessary as a trigger to some of these types of gingival enlargement, but it seems to be extremely difficult, if not impossible, to obviate this in practice. The pocket produced by these forms of gingival enlargement is usually of the false type although it may be combined.

Pockets formed as the result of neoplasms of the periodontium can only be satisfactorily eliminated by gingivectomy if the lesion arises from the marginal gingivae.

A factor, other than the nature of the pocket or its aetiology, which should determine the suitability for treatment by gingivectomy is the mental attitude of the patient. A successful result will not be maintained, even though it may be initially achieved, if co-operation is not good. Patients who are not prepared to co-operate must be considered unsuitable for all forms of periodontal therapy not only gingivectomy. The gospel that the magnitude of a gingivectomy is sufficient to compel co-operation is a dangerous one, as only rarely will the results of such "shock therapy" produce a favorable result for any considerable period of time.

### FAILURE TO MAP OUT THE POCKET DEPTHS

Making an indication of the pocket depth on the outer aspect of the gingiva is an

Fig. 2. Recurrence of pockets in a case of gingivitis associated with puberty now aged 14 years. Three gingivectomies had been performed between the ages of 12½ and 13½ years.

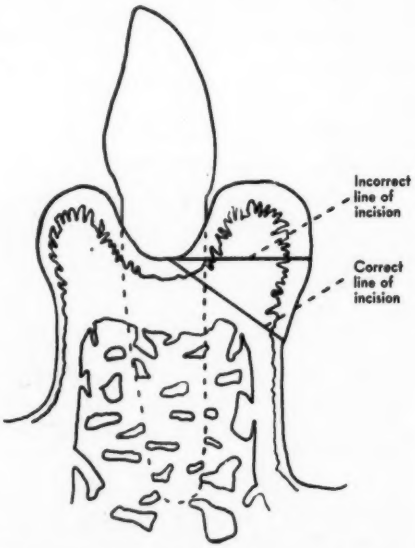


Fig. 3. An interdental area illustrating how a broad gingival plateau and a thick marginal ridge remains if the knife does not enter the tissues at the right point and at the correct angle.

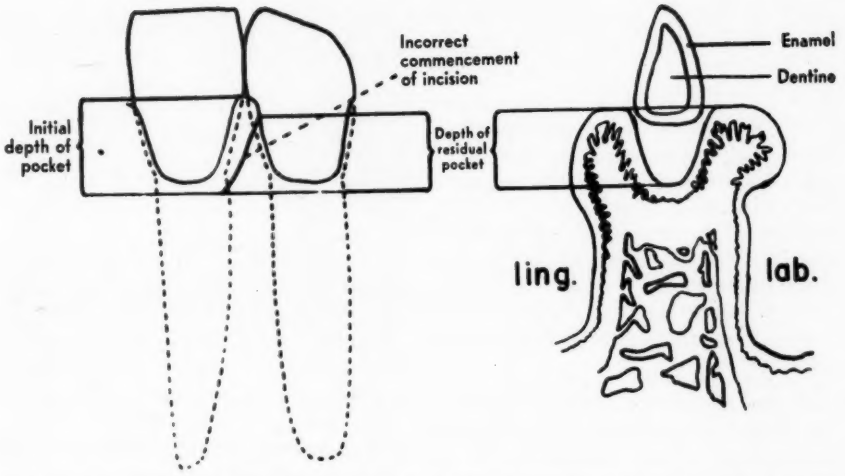


Fig. 4. Showing how a residual pocket is left if an incision commences or terminates in a papilla instead of in an inter-papillary region.

invaluable aid in correctly performing the operation. This is achieved by the use of Crane-Kaplan pocket marking forceps, which must be used as two pairs, a left and a right, in order to give a true record.

By this method only can one achieve the object of deleting pockets and producing a physiologically satisfactory gingival bevel without involving the epithelial attachment. Removal of the epithelial attachment is unnecessary as it produces an increase in the clinical crown at the expense of the clinical root (Ritchey and Orban, 1952). Failure to map out the pocket depths may bring about the removal of insufficient or too much gingival tissue, and may, on some occasions, produce exposure of the bone of the alveolar process (Fig. 3).

### COMMENCING OR TERMINATING THE INCISION IN A PAPILLA

The greatest pocket depth in cases where there is a generalized destructive lesion of periodontal tissues is usually in the interdental region. Commencing or terminating an incision in an interdental papilla will, therefore, fail to eliminate the pocket at the juncture between treated and untreated regions (Fig. 4).

The points of commencement and termination should always be in an inter-papillary region. This is particularly important when a whole jaw is to be gingivectomized at a series of operations.

### CUTTING WITH INSUFFICIENT OBLIQUITY

Gingivectomy is defined as the operation of cutting away all loose, infected and diseased gingival tissue to eradicate periodontal pockets (Miller, 1950). Similar definitions are made by Goldman (1949) and Glickman (1953). Eradication of the pockets is not in itself sufficient. A physiological form must be given to the gingivae at the same time. A physiological form is one in which food is shed from the gingivae with the greatest ease and their cleansing by both natural means and artificial aids is most readily performed.

The important feature in achieving a physiological form is not cutting along a scalloped line, but rather along a straight line holding the knife so that a sufficient

degree of bevel of the gingival margin is obtained. The bevel should be at an angle of approximately 45 degrees to the long axis of the tooth (Fig. 3).

To achieve this the cutting edge of the knife blade should enter the tissues at a point 2-3 mm. apical to the puncture marks made by the Crane-Kaplan pocket marking forceps on the superficial aspect of the gingivae. If the blade is then made to penetrate the tissues at as oblique an angle as its bulk and the width of the alveolus will allow, the desired degree of bevel will be achieved.

Failure to cut with a sufficient degree of obliquity will leave thick gingival margins and a broad plateau interdentally. The extent of these will depend upon the degree of fibrosis which has occurred in the tissue of the marginal gingivae.

### FAILURE TO ELIMINATE POCKETS

Even though a sufficient obliquity of cut is made and the pockets are mapped out beforehand by Crane-Kaplan forceps, gingival pockets will only be eliminated if care is taken to enter the tissues the requisite 2-3 mm. apical to the puncture mark.

Incomplete elimination of the pockets predisposes to further destruction of the deeper parts of the periodontium, and is particularly liable to occur if an attempt is made to scallop the gingival margins. The patient will, therefore, have been done a disservice rather than a service.

### LEAVING TAGS

All surgical incisions should be clean, as the ragged surface is one which neither heals so readily, nor produces such a satisfactory final result. Tags of gingival tissue may be left interdentally and occasionally on the lingual or vestibular aspects. The way in which these bits of partially detached tissue respond appears to depend upon their vascular supply and possibly the amount of pressure and irritation to which they are subjected in the post-operative period. If the attachment is slender and a firm and stable pack is applied they will usually slough off and will not be observed when the pack is removed. Should the attachment be by a broad base, however, the tissue is prone to proliferate and troublesome exuberant granulation tissue may be experienced.

To prevent tags of tissue being left two precautions, other than those already mentioned, must be exercised. The cutting edge of the knife must be really sharp and maximum penetration of the tissues must be made. Sharpening surgical instruments is a skilled task, and for this reason an instrument utilizing a removable blade is best. Gingivectomy knives incorporating this principle are the Monahan Lewis, the Trotter (Fish, 1952), and the Blake (1950). For the first pair special blades are manufactured and these do not permit a continuous incision. This objection, however, is overcome by the Blake Universal knife in which the very widely used Bard-Parker range of blades are fitted. The sharpness of these blades can be guaranteed.

When using a gingivectomy knife care should be taken to penetrate the tissue to its full depth and contact with hard tissue should be made. The blade must then be kept closely applied to the tooth surface throughout the course of the incision, being made to enter the interdental areas as far as possible. It is essential that the incisions on both lingual and vestibular aspects should be made before any attempt is made to elevate the tissue. By carefully following these minutiæ very few if any tags of tissue will remain.

Should any tags remain, they can be best and most expeditiously removed by means of electrosurgery. In the absence of this it is often possible to curette them away with a sharp sickle-shaped instrument, or to destroy them by the application of a caustic.

### INACCESSIBLE INTERDENTAL SPACES

It is generally agreed that if a destruc-

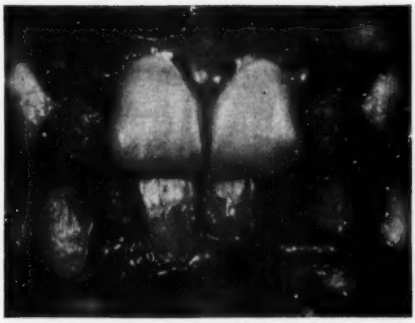

Fig. 5. The degree of imbrication is so great that access to the interdental spaces would be inadequate and a recurrence after treatment by gingivectomy alone would be highly probable.

tive type of periodontal lesion has given rise to interdental spaces these must be kept free of debris and calculus if further destruction is to be prevented. Resection of the detached gingival tissue makes this much easier than it was when the extraneous matter was in the depth of a pocket.

Clinical experience has shown that the gingival base of an interdental space must, after a gingivectomy, be treated by passing a wooden stick or some other form of interdental stimulator freely through the space. Whether the action is merely mechanical cleansing, friction or a combination of both is uncertain, for the information with regard to the value of gingival stimulation by friction is uncertain and indefinite (Wade, 1954).

Unless the teeth are malposed the passage of a wood stick or other agent of similar size should always be possible. Failure to eliminate the detached gingival tissue or to remove calculus from the proximal aspects of the teeth will make this impossible. If the degree of malpositioning of the teeth is such that interdental spaces are extremely narrow or inaccessible the case must be considered unsuitable for treatment by gingivectomy (Fig. 5).

After removing the excised tissue the spaces should always be tested for size by the passage of an instrument of similar bulk to the smallest size of interdental stimulator available, or the stimulator itself may be tried. Agents such as floss silk, wool yarn or elastic bands (Emslie, 1953) help in cleaning the proximal aspects of the teeth, but it seems impossible that they can be used to provide any frictional stimulation of the gingival tissue. On the contrary there is considerable risk of them being harmful to the supporting tissues.

### INSUFFICIENT PACKING

The prime object of a post-gingivectomy pack is to protect the exposed connective tissue during the initial period of epithelialization. In doing this the pack should produce the minimum amount of impaired function, and should, therefore, be only very slightly greater in bulk than the excised gingival tissue.

A good pack should at its periphery overlap the line of incision by little more than 2 mm. If allowed to extend further than this there is a grave danger of causing ulceration of the mucosa at the periphery of the pack and particularly at the sites of fraena. If the pack is left short of the line of incision irritation of the connective tissue and the ingrowing epithelium will occur. This irritation may produce ulceration or fibrosis with the formation of a roll of tissue and consequently a gingival form which is not physiologically satisfactory.

The interdental space should be completely occluded by the pack in order to prevent stagnation in this area and also to give stabilization. Completely filling the space is not synonymous with pressure packing, which should be avoided as healing and not necrosis is what is wanted.

### LOOSE PACKS

Epithelialization over the raw surface will proceed most rapidly if the area remains undisturbed. The period required to cover the connective tissue completely depends, of course, upon the size of the area

as well as upon the tissue reaction of the individual. It may vary from about four to fourteen days, the average being seven days. Movement of the pack will irritate the tissue and, in addition to delaying the healing process, proliferation may occur producing nodules of granulation tissue.

Patients should be advised of this danger and told to return immediately should the packs be loosened. The packs will then have to be removed and the degree of epithelialization assessed in order that a decision can be made whether to re-pack or give instruction in after care. It is usually impossible to reconsolidate a pack which has become loose, and it is, indeed, inadvisable to attempt to do so.

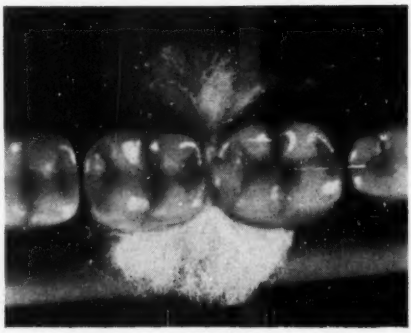

Fig. 6. The "wheat-sheaf" method of inserting a periodontal protective pack.

### LOSS OF PACKS

It has just been stated that on the average the exposed connective tissue has been covered over by newly formed epithelial growth in a week after the operation has been performed. If the packs are lost earlier than this it is probable that the result will not be as good as it might otherwise have been.

Several types of pack have been advocated, but three are now widely used. Cotton wool fibres impregnated with a paste of zinc oxide and oil of cloves is recommended by Fish (1952). Ward (1928) prescribed a surgical cement, and a similar cement which incorporates finely shredded asbestos fibres has also been advised. All of these may be displaced, although the chances of this occurring are reduced if the pack is applied in the precise manner in which the originators recommended.

It has been found, however, that the possibility of the pack being lost can be completely eliminated by using the materials advocated by Fish (1952) in a slightly different manner. He feeds the fluffy edge of a large wisp of cotton wool, which has been dabbed in a soft mix of the zinc oxide-oil of cloves paste, into the interdental space. This leading edge is then pressed firmly *up against the contact point* between the teeth. Packing has to be done from both lingual and vestibular aspects. Here lies the weak point in this technique.

By feeding the fibres into the interdental space in a somewhat drier state with a flat-bladed plastic instrument, the material can be made to pass quite easily right through any space which will permit the passage of an interdental stimulator. When sufficient has been passed between the teeth it can be fanned out in the form of a wheat-sheaf with the constriction in the interdental area (Fig. 6). Sometimes the ends of the fibres will have been turned over in their passage through the interdental space, but if a very small amount is cut off with a pair of scissors no difficulty will be experienced in fanning them out.

Each interdental space in the operated area should be packed in this manner after which, if the right amount of wool has been used, the fanned out parts will contact each other mesio-distally and so completely cover the exposed connective tissue. The paste of zinc oxide and oil of cloves, which should be of about the consistency of soft butter, is then smeared liberally over and among the fibres. A piece of gauze swab of suitable size is dipped in warmed water, rung out and folded over the teeth so as to cover the pack. Placing one's fingers on both lingual and vestibular aspects firm

compression must be applied in order to force the paste in among the fibres and to condense the pack to the desired bulk. Moulding of any surplus material on the crowns of the teeth should follow and the edge of the pack is trimmed with scissors to overlap the cut edge by the 2 to 3 mm. already recommended. Care is also taken at the same time to see that fraena are not impinged upon and a protective coating of vaseline is applied.

This method, the significant part of which is the threading through of the fibres and the wheat-sheafing, will ensure that the pack will not come adrift in the immediate post-operative period.

In eliminating false pockets by surgical excision of the excess gingival tissue the stabilization of a pack presents considerable problems for no interdental spaces exist. Anchorage of any form of pack is virtually an impossible task. Different ways of tackling this very difficult problem have been suggested.

Blass (1928, 1935) has prescribed a varnish for use after scaling and subgingival curettage, but Goldman (1949) advises against its use after a gingivectomy. Waxes of differing compositions and applied in different ways have been advocated by Stones (1932a) and also by Dunlop (1913), Box (1940) and Christensen (1944). Wax packs are more usually used as pressure packs, they tend to break away and may soften when hot food is eaten. They cannot be considered ideal for packing after the surgical elimination of false pockets.

Bunyan (1949) believes that no protective pack is required. He considers that a clot of blood is nature's dressing, and so, if the exposed connective tissue is covered and remains covered by such, epithelialization will progress satisfactorily. He has designed applicators which are box impression trays made in rubber with a hollow tube in place of the handle. These are placed over the respective jaws and the operated area irrigated by passing one pint of a 1 in 5 solution of electrolytic sodium hypochlorite (Milton) at 100 deg. Fahrenheit. This leaves a controlled clot over the raw surface only. The patient is advised to repeat the irrigation before retiring and again the following morning.

Covering the raw surface with adhesive tin foil is, however, the most satisfactory method yet developed for use in areas where interdental spaces do not exist. Advantages claimed for tin foil (Goldman, 1949) are easy application, durability, comfort, minimal seepage, cleanliness and ease with which it can be burnished into grooves and moulded to the tooth surface. To these might be added the property of extremely small bulk. The only disadvantage of adhesive tin foil is an aesthetic one, for it is necessary to cover the entire crowns of the teeth.

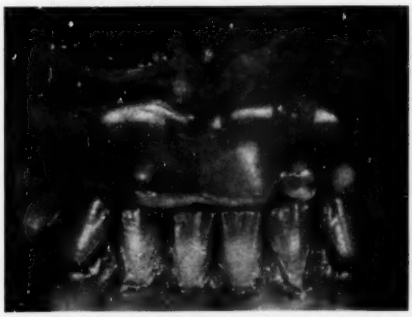

Fig. 7. The transparent latex cover of Munns. A zinc oxide and oil of cloves pack has also been applied under the cover in this case.

A transparent latex cover (Fig. 7) has been used by Munns (1952), whilst acrylic veneer splints have been recommended by McKenzie (1951) and Friedman (1953). The need for prior construction of these appliances for each patient would be regarded by some as a disadvantage. Proof that they would not irritate were a pack not applied beforehand is also required.

### FAILURE TO PRESCRIBE STIMULATORS

It has already been stated that clinical experience has shown that it is necessary to pass a so-called stimulator through the interdental space which has been freed by performing the gingivectomy. This fact does not seem to be appreciated by all who practice this operation. Failure to prescribe interdental stimulators will, however, almost invariably be followed by further periodontal destruction.

The prescribing of interdental stimulators should be done at the visit when the pack is removed and should be accompanied by a demonstration. The patient is requested to hold a mirror in order to watch the clinician use the stimulators. This demonstration serves the twofold purpose of showing the patient how to use the stimulators and of enabling the dentist to ascertain the size and type which is most suitable for the particular area.

If the straight type of stick is prescribed for use in posterior regions of the mouth the patient is likely to experience some difficulty. Rubber cones or wooden sticks mounted in special carriers or in the holes in the handles of toothbrushes usually give adequate access to these areas whilst it has also been suggested that angled acrylic sticks can easily be made to any desired angle and size (Wade, 1953a).

### FAILURE TO USE STIMULATORS

Stimulators should really be used after every meal although it is more usual to advocate use at least twice a day. They should be passed approximately twelve times through each space and should be angled and tilted in order to traverse as much gingival tissue as possible .

After the method of using stimulators has been demonstrated at the visit when the pack has been removed patients should be warned about the possibility of producing bleeding. Slight bleeding and staining of the stimulator may be noticed in the first few days, so they should be told that this only signifies too vigorous use and that they *must* continue in a more gentle manner. Such warning is most important, for many patients will cease to use the stimulators if they observe blood unless they have been very definitely advised beforehand of this possibility and its significance.

Failure to continue using interdental stimulators will, in the majority of cases, lead to an unsatisfactory result, whilst a lapse in their use may mean that a previously satisfactory result will not be maintained. Stimlators are not, of course, needed in cases where false pockets have been treated.

### NON-ELIMINATION OF ETIOLOGICAL FACTORS

No treatment will ever be satisfactory if the etiological factor responsible for the lesion is not eliminated. This is as true for a course of treatment which includes gingivectomy as it is for any other. Elucidation of the etiological factor or factors is, therefore, of paramount importance. Should this be impossible the case must be regarded as one for which treatment by gingivectomy is unsuitable, or if such an operation is performed it must only be done on the very strict understanding that the possibilities of maintaining an improvement are entirely conjectural.

It is preferable to eliminate the etiological factor before excising the unsupported gingival tissue, but at the very latest at the time when the operation is performed. Calculus is the commonest etiological factor which is encountered, and may be acting alone or combined with other factors. There is lack of agreement about the best time at which to perform a scaling and polishing of the teeth if a gingivectomy is to be performed. Doing it a week or ten days before the gingival excision allows the ulcerated crevicular epithelium to heal and the excess gingival tissue to become less severely inflamed. Hemorrhage during the operation will, therefore, be less troublesome. This order is in accord with the best

Fig. 8. An anterior open bite acting as a predisposing factor. A gingivectomy had been performed eighteen months previously and had produced only transitory improvement.

principles of surgery. Objections are the time consumed, the poor access and the difficulty of applying a polish to the planed tooth surface.

Glickman (1953) advocates scaling and planing, at the time of performing the gingivectomy. The advantages claimed are speed and simplicity, but increased hemorrhage must be set against these together with the danger of forcing pieces of calculus into the exposed connective tissue. Probably the best method is a combination of both, the time spent on the pre-operative phase not being allowed to become excessive. Failure to remove the calculus makes insertion of the pack difficult or even impossible, and tends to interfere with the process of healing.

### NON-ELIMINATION OF PREDISPOSING FACTORS

There are certain factors which do not in themselves cause periodontal disease in which pockets are formed, but make the individual more susceptible to such disease. These predisposing factors must be eliminated if the beneficial results of the gingivectomy are to be maintained. Certain predisposing factors, particularly those associated with developmental anomalies such as an anterior open bite (Fig. 8), are often extremely difficult to correct. If correction is not possible the case may well be considered unsuitable for a gingivectomy, or the operation will again be performed on the understanding that the prognosis is doubtful.

### FAILURE TO COMPLETE TREATMENT

The operation of gingivectomy is not synonymous with periodontal treatment. It is only part of a whole course of treatment which is directed towards attaining and maintaining maximum health and function of the masticatory apparatus and a pleasing aesthetic appearance, for such are the aims of dentistry (Wade, 1953b).

Failure to complete the whole may well mean lack of success in the part. Gingivectomy should only be practiced as part of a comprehensive treatment plan.

### SUMMARY

The reasons for unsatisfactory results from the operation of gingivectomy are enumerated and discussed.

Ways of preventing these failures are suggested.

The term *combined pocket* is advocated for one which is both true and false.

Use of the Blake knife is recommended.

A new method, the *wheat-sheaf* method, of applying a pack is described.

Special consideration is given to the problem of pack retention where there are no interdental spaces.

### ACKNOWLEDGMENTS

Assistance given by the technicians of the Photographic and Prosthetic Departments of this School and by my Secretary is gratefully acknowledged.

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# Tooth Mobility (IV)*

## Tooth Mobility Changes Through Artificial Alterations of the Periodontium

*by* HANS R. MÜHLEMANN, M.D., D.D.S.,** *Minneapolis, Minn.*

SOME of the factors involved in the mechanism of tooth mobility (TM) have been analyzed in three previous studies.[1-3] It was found that the degree of TM is influenced not only by mechanical conditions, such as the length of the roots and the width of the periodontal membrane, but also by biofunctional factors. The initial TM of well functioning teeth is relatively small despite rather wide periodontal membranes.[1] In such cases the fiber bundles are coarse, abundant, and dense. Secondary TM was found to be related to the degree of extensibility of the soft and bony periodontal tissues.[3] It decreases with the functional aging of teeth. Rest TM can be activated into activated TM.[2] These findings suggest that TM is not only a function of the *quantity* of periodontal structures surrounding the roots of teeth but that it is to a large degree dependent upon the biophysical *qualities* of these structures.

In order to elucidate the dependency of TM upon the physical qualities of the periodontium, the periodontal tissues were artificially altered. It is the purpose of this report to compare TM before and after thermal and chemical modification of the tooth supporting apparatus. Producing known periodontal tissue changes and studying their effect on TM may deepen our understanding of the biomechanical properties of the periodontal structures under physiological and pathological conditions.

*This is the fourth of a series of reports about tooth mobility.

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## MATERIAL AND METHOD

TM changes were studied on 22 different teeth of seven Rhesus monkeys (MA to MG) of different ages. 1750 TM measurements were made with a dial indicator and a forcemeter. Details of the method were described previously.[1] TM curves were constructed from measurements made (1) in vivo (14 teeth, 60 TM curves), (2) within 17 to 120 minutes after sacrificing the animals (15 teeth, 71 TM curves).

After these in vivo and post mortem measurements the jaws were separated from the skull and (1) exposed to hot water, 80° C., for 5 to 8 minutes, (2) in some cases reexposed to this heat treatment, and (3) immersed in formalin 10% for 1 to 17 days. After these thermal and chemical treatments TM was again measured (21 "heat curves" and 23 "formalin curves") and compared to the in vivo or immediate post mortem data.

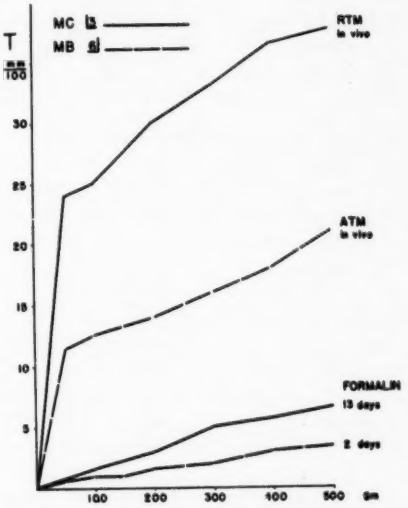


Fig. 1. Loss of in vivo initial rest tooth mobility (RTM) or in vivo activated tooth mobility (ATM) and decrease of secondary tooth mobility by a formalin treatment of the periodontal structures.

## RESULTS

1. *Tooth mobility in periodontal structures altered by formalin* was always dramatically changed (Fig. 1). Formalin treatment annihilated without exception the *initial TM*. The resistance of the formalin fixed structures was so great in the range of initial TM that the initial crown excursions (when applying 100 grams) were up to 12½ times smaller than under in vivo conditions. Therefore the characteristic double-sloped in vivo TM curves were transformed into single-sloped straight lines.

There were also pronounced reductions of the *secondary TM*. They were not due to the loss of the initial TM alone: A comparison of the slope gradients of secondary TM before and after the formalin treatment shows a decrease of the slope gradient (Fig. 1).

During TM measurements the "formalin crowns" rebounded more quickly from their labial and lingual excursions to their rest position. The rebound was also more complete than under in vivo conditions.

2. *Tooth mobility in periodontal structures altered by heat.* The exposure of the periodontium to heat modified TM: the double-sloped TM curves were changed

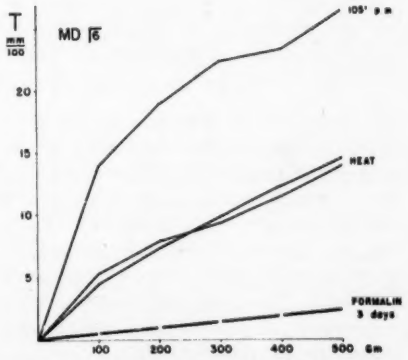


Fig. 2. Loss of post mortem initial tooth mobility by a heat treatment of the periodonal sructures. Further decrease of secondary tooth mobility by a subsequent treatment with formalin.

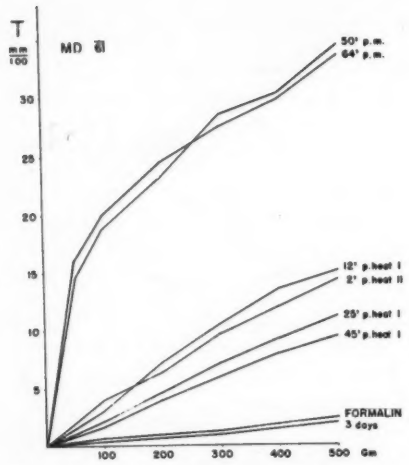


Fig. 3. Loss of post mortem initial tooth mobility by a heat treatment of the periodontal structures. Decrease of the slope gradients during the cooling off of the periodontium (12, 25, and 45 minutes after first exposure to heat I). Increase of secondary TM by a second heat treatment (heat II). Decrease of secondary tooth mobility by a further treatment with formalin.

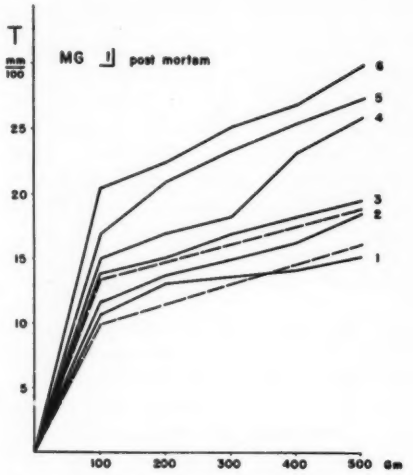


Fig. 4. A selection of tooth mobility curves obtained 17, 25, 32, 38, 50, and 100 minutes (curves 1 to 6) post mortem. Tooth mobility increases over the activated in vivo TM.
Lower dotted line—Rest tooth mobility in vivo.
Upper dotted line—Activated in vivo tooth mobility.

into straight lines (Figs. 2 and 3). The slope gradients of these lines were greater than those obtained from formalin-treated samples. These slope gradients were also dependent on the temperature of the heated periodontal structures (Fig. 3). They were smaller in cooled off than in hot specimens (Fig. 3).

The exposure of heat-treated samples to formalin resulted in a still greater reduction of the slope gradients of secondary TM (Figs. 1 and 3).

3. *Post mortem TM changes* occurred regularly. However they were often inconsistent. TM changed only in degree. The characteristic double-sloped TM curves were maintained (Figs. 2 and 4). There were no apparent differences in animals sacrificed by shooting or by an overdose of Nembutal. The first TM measurements performed post mortem gave values very similar to in vivo *rest* TM. The performance of continuously repeated multiple measurements after the death of the monkeys increased TM in most of the animals *over* the activated in vivo TM. This was the most typical post mortem TM modification (Fig. 4). It consisted mainly of an increase in initial TM.

## DISCUSSION

It has been shown that the characteristic double-sloped in vivo TM curves are transformed into single-sloped tooth mobility "curves" by the exposure of the peridontium to heat or formalin. This loss of initial TM is probably caused by a chemical alteration of the periodontal fibers. *Wöblisch*,[4] *Astbury*,[5] *King and Lawton*[6] showed that tendons or collagen structures contract in hot water† very rapidly to one-fourth or one-fifth of their original length. The contraction is due to an extensive intramolecular rearrangement and violent coiling up of the collagen "molecules." It is conceivable that the same irreversible thermal contraction takes place within the collagenous periodontal structures. The periodontal fiber bundles are shortened by the exposure

†Shrinkage temperature of tendons in water: 52° C.[7]

to heat. Their wavy appearance in microscopic sections of formalin- as well as of heat-treated specimens may be the morphologic picture of this contraction. Such contracted fibers hold the root firmly at the whole periphery, and this situation may be responsible for the loss of initial TM. Noncontracted in vivo fiber bundles allow for an initial intra-alveolar displacement of the root with very low forces (50 to 100 grams). This displacement, associated with a reorientation of periodontal fibers, is measured as initial TM. The contraction of the membrane fiber bundles by heat and formalin makes this initial root displacement impossible. The heat- and formalin-treated periodontium may be compared to a situation where there is no periodontal membrane at all between root surface and alveolar bone, as in ankylosed teeth. Such teeth also have no initial TM.[8]

Moreover, the results demonstrated that heat and formalin change the elastic properties of the periodontal tissues. The reductions of the slope gradients of secondary TM point to modifications in the extensibility of the soft and bony periodontal tissues. The slope gradients of formalin curves are lower than those of heat curves. Heat curve slope gradients can be reduced further by exposure to formalin. These differences in the tissue extensibility suggest that the heat- and formalin effect on collagen structures are not identical. The pronounced effect of formalin on the elasticity of periodontal structures (increase of the modulus of elasticity) is also indicated by the quicker, more elastic rebounding of the "formalin crowns" towards rest position than under in vivo conditions.

In specimens not treated by formalin or heat, it was surprising to find that the first measurements after sacrificing the animals were not significantly different from those of in vivo *rest* TM. However, repeated post mortem measurements increased TM over the in vivo activated TM. This finding is in agreement with post mortem elasticity studies done by *Krafka*.[9] He showed that the ligamentum nuchae and a piece of aorta increased their elongation if they were subjected many times to pulling forces of more than 100 grams.

The findings point out again the value of distinguishing between initial and secondary TM. If TM had been measured in this study with one force only, e.g. 500 grams, changes in the elasticity of the periodontal structures could not have been determined correctly. For an evaluation of changes in the elastic properties of the periodontium the slope gradients of secondary TM have to be known. They can only be calculated if tooth mobility is measured at least with 100 grams and a force higher than 100 grams.

## CONCLUSIONS AND SUMMARY

The physical qualities of periodontal structures of monkeys were artificially altered by (1) killing the animals, (2) by exposing the dissected jaws to heat, and (3) by exposing the jaws to formalin. *Heat* and *formalin* altered the periodontal structures in such a way that *initial TM* disappeared. This was explained with a thermal or chemical contraction of the periodontal membrane fibers.

*Formalin* and *heat* also produced a reduction of *secondary TM*. The slope gradients of secondary TM decreased because of elasticity modifications in the periodontal structures. The modulus of elasticity was higher after a formalin treatment than after an exposure to heat.

In specimens not exposed to formalin or heat, the characteristics of initial and secondary *rest TM* were maintained despite post mortem tissue changes.

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# Tooth Mobility (V)*

## Tooth Mobility Changes Through Artificial Trauma

*by* HANS R. MÜHLEMANN, M.D., D.D.S., *Minneapolis, Minn.*

MUCH has been written about mobility of teeth and occlusal trauma. However, no quantitative data are available. It has been stated recently[1] that there is no satisfactory definition of occlusal trauma. Occlusal trauma is believed to be the result of an interaction of complex masticatory (functional) and non-masticatory (parafunctional) muscular forces with living periodontal tissues. Therefore, occlusal trauma cannot be defined by the amount, direction, duration, rhythm, or character of the local stress since the formation of chronic traumatic periodontal lesions is also dependent upon the biological reaction of the periodontal structures. Great and heavy forces may be perfectly well tolerated in the presence of an optimal periodontal biological factor whereas much smaller forces may be harmful if the biological response to these forces is "insufficient." Some basic knowledge of the behavior of the mobility of teeth under the influence of mechanical forces, different in character and duration, could enhance the understanding of occlusal trauma. In the present report, changes of TM** were studied by applying different types of forces on crowns of teeth for one to four weeks. In order to obtain a biologically optimal and rather uniform response to local stress, healthy children were chosen for this study.

### MATERIAL AND METHOD

The changes of TM were studied in a group of 30 children, 7 to 15 years of age. 2124 TM measurements were made on 70 teeth before and during the application of different types of forces to the upper incisors. The changes of TM were followed in most of the children during a four-week period, checking the TM four to six times. Only the $T_{500}$ determinations (total labiolingual crown excursions produced with 500 grams) are used in this report. TM was registered with the method described previously,[2] with the one exception that a greater dial indicator, fixed on a special

*This is the fifth of a series of reports about tooth mobility.

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**The abbreviation TM is used to designate tooth mobility.

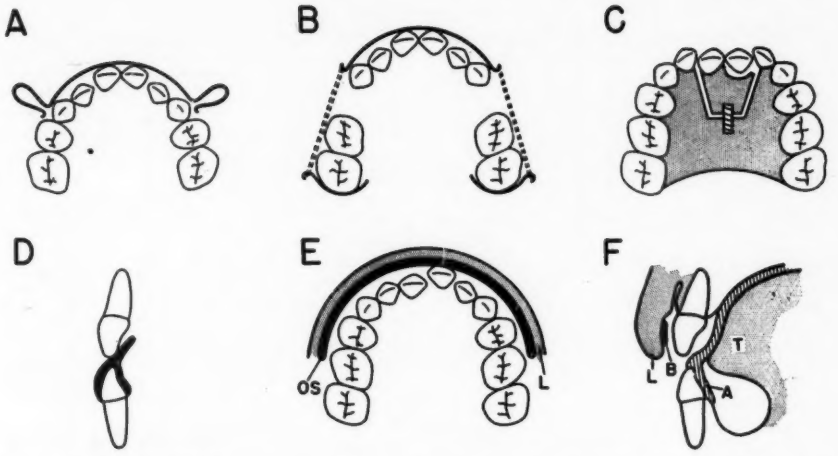


Fig. 1. Appliances used to apply different forces on upper incisors. A—Labial arch wire on Hawley retainer. B—Rubber elastics (———) on Hawley retainer. C—Screw in modified Hawley retainer. D—Non-removable inclined plane. E—Oral Screen (OS). Lip musculature (L). F—Construction used to reduce lingual and labial muscular stimuli (A—Acrylic block, B—Band to hold the lip (L) off, (T)—Tongue.

impression tray, was used.[3,4] The traumatizing forces were applied with orthodontic appliances. The forces were different in character, some being "artificial," some being "functional." Finally, in other cases, functional forces were prevented from acting upon the teeth. The following types of forces were produced by different appliances (Fig. 1-A to 1-F):

1. *Artificial Forces*

   A. *Spring forces* originating in a labial arch (0.8 mm diameter of wire) of a removable modified Hawley retainer (Fig. 1-A)

   B. *Elastic forces originating in* orthodontic rubber elastics* and transferred to the teeth by means of a rigid labial arch attached on a modified removable Hawley retainer (Fig. 1-B)

   C. *Screw-type forces* originating by the activation of a screw built in a removable modified Hawley retainer (Fig. 1-C). One activation of the screw pushed the crown of an incisor over a distance of six-hundredths of a millimeter.

II. *Functional Forces.* Functional orthodontic forces originating in the masticatory and oro-facial musculature of the child. Two types can be distinguished:

   D. *Masticatory forces.* They were transferred to teeth by the use of non-removable fixed inclined planes (Fig. 1-D). Masticatory forces originate probably also but to a less degree in the intermasticatory periods.

   E. *Non-masticatory forces.* They originate primarily within the oro-facial musculature. They were transmitted to the teeth by means of removable rigid appliances worn only during night. An appropriately constructed oral screen or mouth shield (Fig. 1-E) was introduced be-

*The rubber elastics corresponded to #IX that is furnished by the Ortho-Specialty Company, Chicago.

TABLE I

*Increases of Tooth Mobility ($T_{500}$) During the application of Different Types of Forces (Orthodontic Appliances)*

| *Type of Force* | *Force Originated by* | *Duration of Force* | *Appliance* | *Removability of appliance* | *Most Frequent Increases of $T_{500}$ mm/100* |
|---|---|---|---|---|---|
| artificial | spring action | day and night | labial arch on Hawley retainer | + | 30 |
| artificial | rubber elastic | day and night | modified Hawley retainer | + | 40 |
| artificial | screw action | day and night | modified Hawley retainer | + | 13 |
| functional | masticatory musculature | day and night | inclined plane | − | 20 |
| functional | lip musculature | night only | oral screen | + | 7 |

tween the labial musculature and the anterior portion of the dental arch. The interposition of an oral screen between lips and dental arch creates an imbalance of the previously existing muscular equilibrium between the lips and the tongue, which is used for retrusion of protruded front teeth.[5]

F. *Reduction of functional forces.* Some of the children wore appliances—during the night only—which were constructed to prevent the transmission of masticatory as well as linguolabial muscular stimuli on the teeth (Fig. 1-F).

The forces produced by labial arches and rubber elastics were within 100 to 150 grams. They were, for the screw, 150 grams at the moment of insertion of the appliance. If any pain was produced by the appliances the children were instructed to remove them. All the forces were reactivated every five days. The magnitude of the functional forces could not be determined.

## RESULTS

The most characteristic changes of tooth mobility ($T_{500}$) produced by different forces are presented in Table I. Figures 2-A to 2-F are representative cases of each of the different forces used. $T_{500}$ is plotted against time in days. The age of each child, the teeth treated, and control teeth are listed.

The following information is gained from the data of all measurements:

1. Tooth mobility ($T_{500}$) of upper central and lateral incisors varied at the beginning of the treatment between 16 and 44 mm/100. The *average* TM in the 7 to 15-year age group of boys and girls was $T_{500} = 28.1 \text{ mm}/100 \pm 0.7$.

2. Table I gives the most frequent values of $T_{500}$ increases in relation to the different forces used. It can be seen that TM augmentations were highest when using artificial spring and elastic forces. Forces originating in a screw gave a continuous but slight increase of TM. Trauma produced by the masticatory musculature by means of *non-removable* inclined planes increased TM moderately. Increases were definite but small by the action of the lip musculature.

3. In teeth from which functional muscular stimuli were held off $T_{500}$ decreased. Figure 2-F represents a case treated in this way. In the 8-year old child TM of the upper incisors decreased gradually after an artificial hypofunctional state was produced during night only. The same was

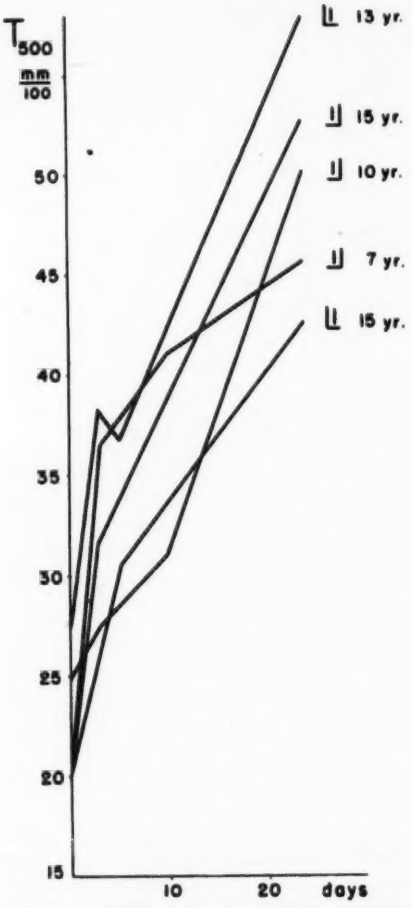


Fig. 2A. Mobility changes ($T_{500}$) of teeth under the stress. Artificial spring force produced by labial arch wire (see Fig. 1-A). Observation during 10 to 30 days.

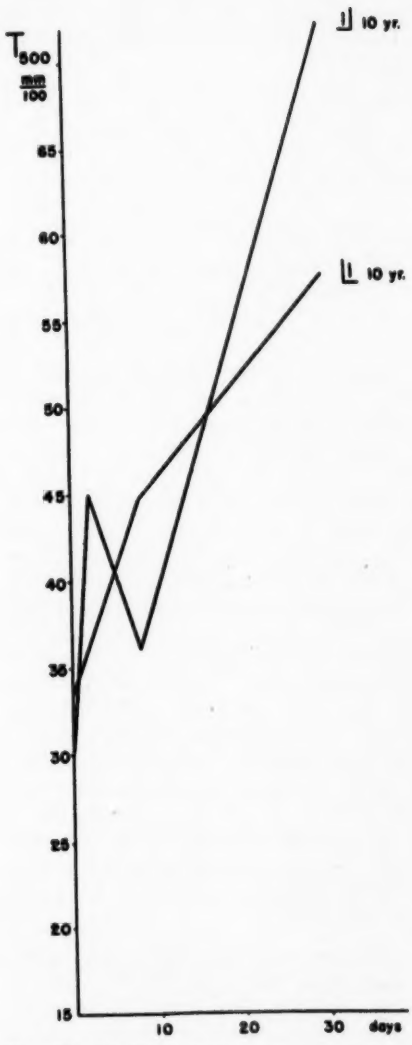


Fig. 2B. Artificial elastic force produced by rubber elastics (see Fig. 1-B).

seen in another 8-year old child (Figure 2-D). The control tooth in this case treated by the inclined plane was out of masticatory function during day and night.

4. The removal of forces which had produced an augmentation of TM was followed within a few days by a decrease of mobility.

5. In some children of the same age, sex, and development and treated with identical appliances and forces, differences of TM increases were observed.

## DISCUSSION

The reported results were obtained under fairly similar biological conditions. One may be allowed to assume in these children

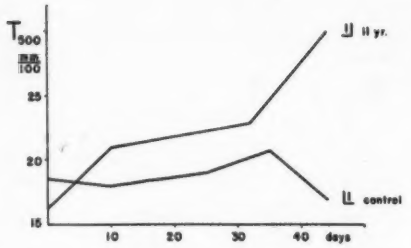


Fig. 2C. Artificial screw force (see Fig. 1-C).

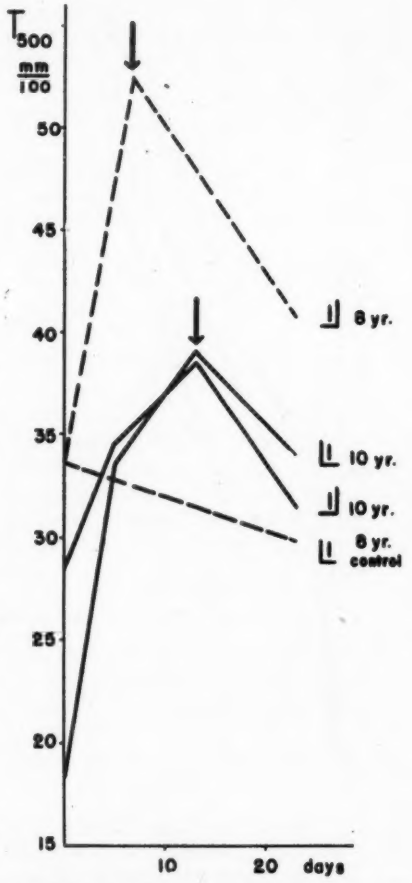


Fig. 2D. Functional force produced by the masticatory musculature. (Increase of TM in both cases until removal of the inclined plane (1D). Immediate decrease of TM after removal of inclined plane. The upper left incisor of the 8-year old boy was in a state of hypofunction during the orthodontic treatment. Decrease of mobility. See Fig. 1-D).

"normal" oral physiological reactions to local stress. There were significant differences in the increases of TM when using different forces. An increase of *functional* forces influencing the teeth was *always* accompanied by an augmentation of TM. Decrease in function, even if only during the night, was associated with a decrease of TM in the first weeks of hypofunction. These phenomena support the contention that TM changes in periodontal patients may also be associated with disturbances in the magnitude and direction of functional forces influencing the teeth. Occlusal trauma may thus have a definite relation to tooth mobility. This is not a new conclusion since gross changes of mobility during occlusal trauma have been shown by ordinary clinical methods. However, with the present measuring method slight changes of altered or abnormal stress can be determined.

The increases of mobility were highest when using rubber elastics. The question arises whether there would be under experimental or clinical conditions a level of TM increase beyond which one could speak of "abnormal" stress producing irreversible traumatic periodontal lesions. This study gives no information in this respect, except that orthodontic procedures (inclined planes, oral screen) can be performed within the range of very low TM increases (10 to 20 mm/100 for $T_{500}$). However, it must be emphasized that *under non-experimental conditions an increase of TM per se cannot be considered to be the consequence of abnormal stress.* Only a decrease of TM following the elimination of suspected traumatogenic factors can be expected to have a causal relationship to abnormal occlusal overcharge. This contention is based on the fact that the removal of traumatic forces resulted in an immediate and distinct reduction of increased TM (Fig. 2-D).

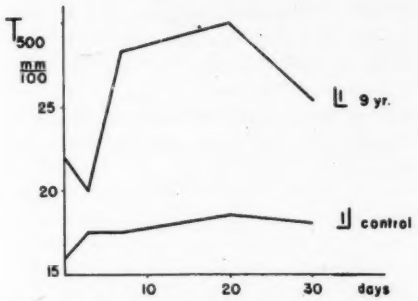


Fig. 2E. Functional forces produced by the lip musculature (see Fig. 1-E).

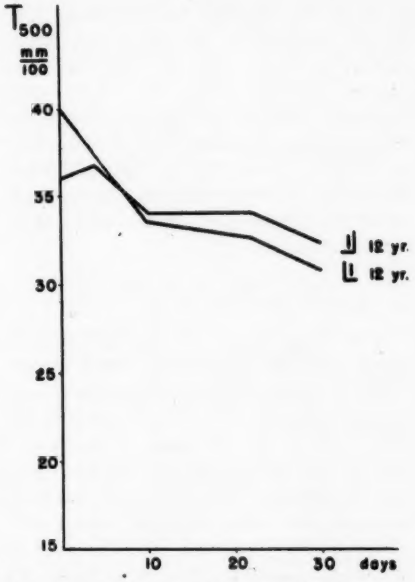


Fig. 2F. Decrease of TM during hypofunction (see Fig. 1-F).

In discussing the pathogenic role of occlusal trauma in periodontal disease it is common practice to enumerate as traumatogenic factors such conditions as deep overbite, steep cusp inclination, cusp interference, and premature contact. The absence of periodontal lesions under these mechanically unfavorable occlusal conditions is frequently used to emphasize that abnormal occlusal stress is not a significant factor in the etiology of periodontal disease. Such reasoning implies the tacit assumption that in cases of premature contact, steep cusp inclination, or similar mechanically unfavorable conditions, there *must* also be an increased or altered occlusal stress acting on the periodontal structures. This assumption has probably produced more confusion in the discussion of occlusal trauma than any other contention. One is not justified to assume, in the presence of a mechanically unfavorable occlusal situation which *could* be traumatogenic, that unaltered periodontal structures are resistant to trauma and that, therefore, trauma is no significant etiologic factor in periodontal disease. Such a statement is unscientific and wrong as long as there is no evident proof that the mechanically unfavorable occlusal situation actually *is* causing increased or altered occlusal stress. "Abnormal" occlusal stress is always associated with TM increase. We have shown that slight modifications in functional stimuli transmitted on teeth produce significant TM alterations. TM augmentations occur frequently also by nontraumatic conditions.† Therefore, a mechanically unfavorable occlusal situation can only be assumed to cause abnormal stress if it can be shown that:

1. TM is increased, and that

2. the increased TM decreases after the elimination of the factor supposed to be traumatogenic.

The absence of increased TM in the presence of a mechanically unfavorable condition proves that this condition is not traumatogenic.

The term "abnormal occlusal stress" cannot be defined in an absolute manner by indicating the specifications of the forces transferred to the periodontium. It was apparent in the present study that some children, despite similarity of age and sex, showed different mobility increases even when the same forces were applied to the teeth. Evidently the term "abnormal oc-

†Details will be reported later.

clusal stress" involves the individual biological reactions of the periodontal structures. It seems logical, therefore, to investigate more extensively in adults TM changes produced by controlled overstress in an attempt to define abnormal occlusal stress and trauma. On the basis of such a criterion a rational and scientific approach to the role of occlusal trauma seems to be more successful.

## CONCLUSIONS AND SUMMARY

TM changes were studied in children. Forces originating in spring wires, rubber elastics, screws, or in the masticatory and oro-facial musculature were applied to the teeth for one to four weeks. It was found that tooth mobility rapidly changed under the influence of these forces. TM increases were highest when *artificial spring and elastic forces* were used. The changing of the magnitude and direction of *functional forces* transmitted on teeth produced also definite TM modifications. It must be concluded that abnormal occlusal stress is associated with increased TM but that the diagnosis of "occlusal trauma" is allowed only if an increased TM decreases after the elimination of a suspected traumatogenic factor.

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## DR. ISRAEL MILLER

1887-1954

Dr. Israel S. Miller, periodontist in New York city, and active member of the American Academy of Periodontology, died in New York on May 21, 1954, his seventy-sixth birthday. Dr. Miller practiced general dentistry for forty-five years, but since 1921 devoted most of his time to periodontia. He gave many clinics and read many papers on periodontal diseases before dental societies, and was most faithful in attending meetings and seminars on periodontology. He was also a past president of the Hudson County Dental Society, and served on many important committees.

# Oral Hygiene Habits of Young Children

*by* LILLIAN O. DAHL, D.H. AND BEATRICE B. DAVIS, D.H.,* *Bloomington, Indiana*

THE state of oral cleanliness and its parallelism to a partial reduction of dental caries still lacks unequiviocal experimental proof, but it is inconceivable that some beneficial action to the teeth and supporting structures will not follow the initiation of tooth brushing and other oral hygiene habits that cleanse the hard and stimulate the soft tissues.[1] Hine[2] indicates that two requirements must be fulfilled for tooth brushing to be effective in reducing caries: one, that it be performed immediately after meals and, secondly, it must be performed thoroughly. Fosdick[3] has indicated a reduction in dental caries by having his subjects brush their teeth immediately following each meal. However, these studies were strictly experimental in nature, and it is difficult to imagine an unsupervised child population group brushing their teeth three or four times a day. Robinson[4] further points out that the average young adult spends about 67 seconds in brushing his teeth, and thus, it does not seem possible that sufficient time is allotted to a thorough cleansing of the teeth in order to reduce tooth decay materially. Wisan and Gruebbel,[5] through a survey conducted by sending questions to families through the mail, have shown that approximately 43 percent of the people in this survey brushed their teeth 2 times a day and only 19 percent 3 times a day. Also, it was found that the preferred time of brushing the teeth was before breakfast and before retiring. However, it has been a frequent finding that tooth brushing regardless of the time of day it was performed, is effective in reducing the population of bacteria in the mouth.[6] Thus, one must conclude that the oral hygiene habits as now practiced by the American people must not be effective in reducing the mass incidence of dental caries but if conducted under the proper circumstances might be beneficial in partially reducing the dental caries experience in children. In fact, Gruebbel and Wisan[7] have shown that four-fifths of the tooth brushes in use in a cross section of American homes are not suitable for toothbrushing and oral hygiene purposes.

As a portion of the basic research study at Indiana University, Bloomington, Indiana, on the incidence and progression of dental caries in children, a study was conducted in order to learn more about toothbrushing habits and oral hygiene practices of the participating children. The data reported in this paper was designed to answer: how frequently did the children in the unsupervised study program brush their teeth; at what time of day did they brush their teeth and how long did it take them each time; is sex a factor in oral health; did the oral hygiene improve materially by the inclusion of the child in the study program and what form of stains were most commonly found on the children's teeth. No conscientious efforts were made to change or improve the brushing habits of the children.

TABLE I

*The time of day 511 children, participating in a dental survey, brushed their teeth*

| *Time of Day* | *Number of Children* | *Percentage* |
|---|---|---|
| Before breakfast | 47 | 9 |
| After breakfast | 67 | 13 |
| Before lunch | 1 | 0 |
| After lunch | 1 | 0 |
| Before dinner | 0 | 0 |
| After dinner | 9 | 2 |
| After breakfast and after dinner | 73 | 14 |
| After breakfast, lunch and dinner | 25 | 5 |
| After breakfast and before bed | 97 | 19 |
| Before breakfast and before bed | 46 | 9 |
| Before bed | 120 | 24 |
| Irregular | 25 | 5 |

*Indiana University.

## EXPERIMENTAL PROCEDURE

A total of 514 children ranging in ages from 6 to 15 years and divided about equally as to sex were selected at random from the Bloomington, Indiana city and parochial school systems. These children entered the study program throughout a period of six months and were used as a source of information for this study. At the initial visit, the child was given a prophylaxis and full mouth bite-wing x-ray examination. In addition, a careful oral examination was conducted in order to evaluate the dental caries status of each child. The parents were questioned as to the time of day the children brushed their teeth and how frequently the toothbrushing was performed. Previous to the dental prophylaxis, one of the dental hygienists recorded the oral hygiene of each patient along with the presence of stain or pigmentation of the teeth. Following this, the child was taken into a room where he was given a new tooth brush and a tube of dentifrice and asked to brush his teeth exactly as performed at home. The time it took him and the method of brushing was recorded by a hygienist positioned in such a manner as to be unnoticed by the patient. The thoroughness of the brushing was then evaluated by one of the hygienists.

After a period of six months the child returned to the study clinic for the identical treatment of prophylaxis, x-rays and oral dental caries examination. At this time the hygienist again repeated her evaluation of the oral hygiene. The same dentist confirmed the condition of the mouth as determined by the hygienist and the same hygienist made the re-evaluation of oral hygiene in every instance, so that any errors due to the clinical estimations were held to a minimum.

## DATA AND DISCUSSION

The data obtained in this study are shown in Tables 1 through 4. Table 1 shows at what time during the day the teeth were brushed by the participating children, and indicates that the one most frequent time of brushing the teeth is before retiring. Also, 47 children, or about 9 percent, brush their teeth immediately upon arising. Thus if the figures for the combined brushing before breakfast and before retiring are combined with these, it is seen that over 40 percent of all the children in the program brush their teeth at such a time during the day that a relationship between food ingestion and its removal for caries prophylactic reasons does not seem possible. These figures corroborate the data from the survey conducted by Wisan and Gruebbel who also indicate that the majority of the children in their study brush their teeth upon arising and before retiring. The next largest number of children, 97 children or about 19 percent, brush their teeth about twice a day and indicate it to be after breakfast and before retiring. Only 5 percent indicated that they brushed their teeth three times a day immediately following meals. This latter finding is reasonable if one examines the data in Table 2 which shows the frequency with which the children brushed their teeth. It is seen that the participating girls brushed their teeth on the average of 1.5 times a day and the boys performed this method of oral hygiene but 1.3 times per day. Thus it would not be expected to find a large percentage of the children not being in the group which brushed their teeth three times a day. In fact, except for the group brushing their teeth twice a day, which was after breakfast and before retiring, and after breakfast and after dinner, all other groups represented in the study, or 53 per-

TABLE II

*Frequency of brushing per day and time required*

| | *Frequency* | *Time (in minutes)* |
|---|---|---|
| Male | 1.3 | 1.02 |
| Female | 1.5 | 1.10 |

cent, brush but once daily. From the data secured from these children it seems that the preferred method of brushing the teeth immediately following meals is not practiced except by a small fraction of the study population. Even with the constant bombardment of commercial advertising it seems as though the majority of the children still brush their teeth at times not related to the most efficient removal of food debris from the mouth. One wonders if brushing the teeth immediately after the ingestion of food is of such an importance in reducing the caries experience as indicated by one worker,[3] and if the failure to educate the laity through the profession to the importance of this oral hygiene practice is not of serious consequences. It appears that oral hygiene is improving over what used to be practiced but still dental caries is increasing.

TABLE III

*Condition of oral hygiene at initial visit to clinic and the oral hygiene 6 months later in the same patients*

*Initial Oral Hygiene (percentage of subjects in each category)*

| | *Very Good* | *Good* | *Fair* | *Poor* | *Very Poor* |
|---|---|---|---|---|---|
| Male | 8 | 47 | 37 | 7 | 1 |
| Female | 13 | 38 | 44 | 4 | 1 |
| | *6 Months Later* | | | | |
| Male | 7 | 55 | 29 | 5 | 4 |
| Female | 9 | 54 | 32 | 5 | 0 |

Table 2 also indicates the time it takes the average boy or girl in the study program to brush his or her teeth. It takes about the same time for both the girls and boys to brush their teeth, the time required being approximately 1 minute. However, it appeared that the girls were somewhat more concerned about brushing their teeth than were the boys, and examinations made after both groups were finished brushing indicated that the girls mouths were usually more clean than the boys, although the few seconds longer that was required for the girls does not adequately appear to differentiate this fact.

The data in Table 3 indicates the state of oral hygiene at the time of the initial examination and the second examination, or six months later, in the same participating children in the study program. The purpose of collecting such data was to determine whether the participation in the study program alone served as an impetus spontaneously to improve the oral hygiene of the children. The values shown are in percentage of children in each group and indicate that at the initial examination 85 percent of the boys and 82 percent of the girls were classified as having a fair or good state of oral hygiene as judged by an absence of excessive materia alba or other exogeneous oral debris. A total of 8 percent of the boys and 13 percent of the girls were classified as having a very good or excellent state of oral hygiene while 8 percent of the boys and 5 percent of the girls were classified as poor or very poor. After six months the same boys showed that 84 percent were again classified as fair and good and so were 86 percent of the girls. Thus, it appears from this limited evidence that simply participating in the study program did not serve as a dramatic influence for either the boys or the girls to increase markedly their oral hygiene. However, it was the pronounced opinion of both the dentist and the oral hygienists that at the time of the second examination the mouth appeared more clean and cared for, but since the data in Table 3 does not disclose this fact, it is difficult to ascertain the true status. It does appear that the girls have a tendency to possess a better state of oral hygiene at the time of the second examination than the boys, since initially 44 percent were classified as fair and 38 percent as good.

Table 4 relates the nature of the pigmentation or stains on the teeth of the participating children. Of the 514 children initially examined, 17 percent, or 83 children, had a definite classifiable form of

stain or pigment occurring on the teeth. The types of pigmentation are seen in Table 4 and the distribution of these stains indicates that the predominant type is the green stain, while the black variety is the next most frequently found. Gray, brown, and smoke stain compose the balance of the group, and may not be a primary consideration as individual groups, since it is with some difficulty that the various shades of black stains are distinguished. It is interesting to compare the initial data with that found occurring 6 months later, for after 6 months almost all of the typical green stain had disappeared. It appears that this stain is associated with definite malhygiene since it is easily removed and with improved oral hygiene can be almost prevented from re-occurring. There were 72 percent of the group in the green stain category initially but six months later only 4 percent was found to have re-occurred. In relation to the data in Table 3 which appeared to indicate that the oral hygiene had not dramatically improved in a period of six months, the conclusion from these data seem to show that the children did improve the oral hygiene or else the green type of stain would have reappeared. Perhaps the presence or absence of materia alba as being important criterion in judging the state of oral hygiene is not entirely satisfactory and perhaps other criteria such as the presence or absence of pigmentation may be more useful.

TABLE IV

*Distribution and type of stain found on children's teeth*

| | *Initial* | *6 Months Later* |
|---|---|---|
| Green | 60 | 3 |
| Black | 13 | 7 |
| Gray | 3 | 0 |
| Red | 0 | 0 |
| Orange | 0 | 0 |
| Smoke | 4 | 2 |
| Brown | 3 | 4 |

The green stain was located most generally around the cervical areas of the teeth, especially on the labial surfaces of the anteriors, and in certain instances occupied a considerable area on the tooth surface. If the condition was quite severe, the normally found pitted areas of local demineralization were noticed, and some impression of localized penetration of the pigment into the surface of the enamel was observed. The group having black stain also decreased from 16 to 8 percent, but since this type of stain does not represent that normally found in the typical unhygienic mouth group, the interest is not focused on this group as an indication of improved oral hygiene. There was no predominant black stain in either sex, but since the age group was young, the possibility of black stain being contributed by smoking is obviously quite limited. The blackish-gray variety of stain was typically found occurring as a thin line around the cervical and interproximal spaces, and the difficulty of removing it completely varied with the severity of the case but as a group was considerably more tenacious than the green stain. No red or orange, or other stains that may result from chromogenic bacteria were found.

## SUMMARY

From examining the toothbrushing habits of 514 children, ages 6 to 15 years, the following facts were evident: 1. Parents reported that the most frequent time of brushing the teeth was before retiring and before breakfast. These combined times included over 40 percent of the children studied. About 5 percent brushed their teeth three times daily after meals. 2. Direct observations indicated that the time required to brush the teeth amounted to about 60 seconds in the boys and 70 seconds in the girls. In examining data secured from parents, it appears that the frequency of brushing is about 1.4 times per day for the entire study group. 3. Little evidence was found that indicated an improvement in the oral hygiene of the children brought about by simply participating in a dental

caries control program which stressed toothbrushing. 4. It is suggested that the degree of pigmentation on teeth may be a more satisfactory criterion to indicate state of oral hygiene than the degree of materia alba on the teeth.

Acknowledgement: The authors wish to thank Doctor Joseph C. Muhler for his help and suggestions throughout this investigation.

The authors wish to acknowledge the assistance of Shirley Hodgson for her help in the collection of a portion of the data used in this study.

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# Elimination of Periodontal Pockets by Root Amputation*

*by* THOMAS F. MESSINGER, D.D.S. AND BALINT ORBAN, M.D., D.D.S.,
*Colorado Springs, Colorado*

IT IS considered a basic principle in periodontal treatment that pockets have to be eliminated. The Nomenclature Committee of the American Academy of Periodontology has defined a pocket as a pathologic condition of the gingiva. The soft tissues forming one side of the pocket are inflamed. If the tissues are not diseased, but appear clinically healthy, we speak of a sulcus, regardless of depth. To eliminate a pocket should, therefore, mean to change it into a sulcus. This can be achieved through different means—by scaling, subgingival curettage, gingivectomy, flap operation, chemical agents or electro-coagulation.

The following cases give us an additional example of how a deep pocket can be eliminated.

The first case involved the right upper second molar of a 33 year-old male (T. DeW.). A year and a half previously, the upper right first molar had developed a periodontal abscess and was extracted. Six months later the second molar appeared as seen in Figure 1 (A). The gingiva was healthy around this tooth at that time. A fixed bridge was constructed from second molar to second bicuspid. About a year after the bridge was set, the patient developed a deep pocket on the disto-buccal root of the second molar and an abscess on the buccal surface. The abscess was opened, freeing the patient of pain.

The tooth appeared in the roentgenogram as seen in Figure 1 (B). The bone was

*From The Colorado Dental Foundation.

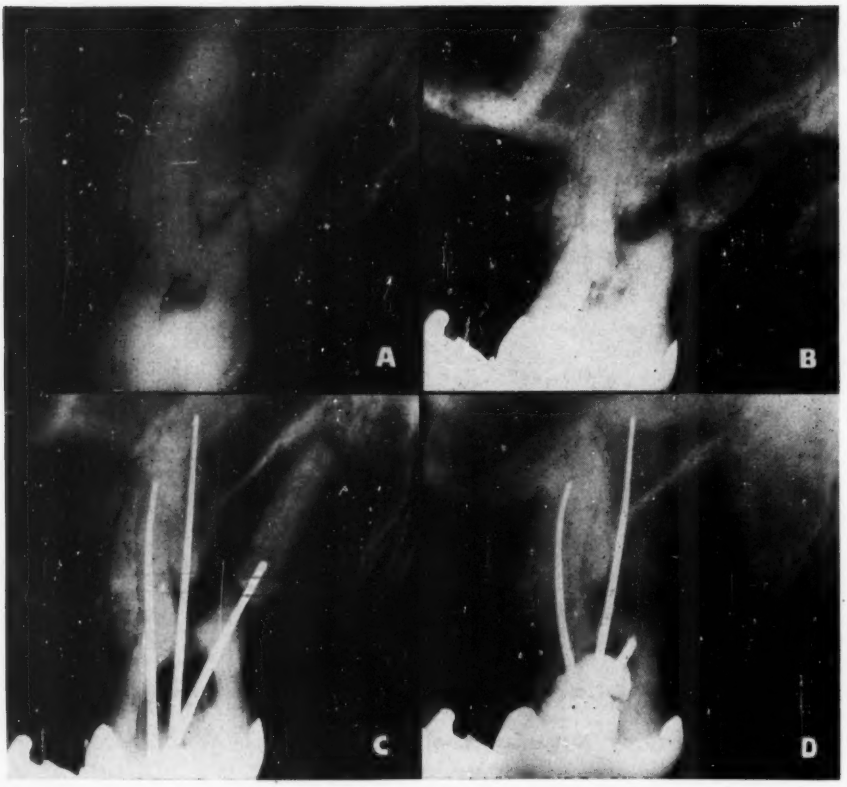


Fig. 1. Right upper second molar. (A) The tooth shows no periodontal involvement and was used as a bridge abutment. A year later, a deep pocket developed on the disto-buccal root (B). Endodontic treatment was carried out (C). Distal root was amputated and extracted (D). Thus, the pocket was eliminated.

resorbed all around the disto-buccal root, involving the trifurcation. It was technically impossible to eliminate this pocket with any of the prescribed methods for pocket elimination and therefore the following procedure was employed.

The pulp chamber was opened and the coronal as well as the radical portions of the pulp were removed. After two treatments of sterilizing the root canals with PBSC compound, the canals were filled with zinc oxide cement and silver points (Figure 1) (C). The disto-buccal root was amputated just beyond the cemento-enamel junction and extracted. *Thus, the pocket was eliminated.* Healing took place uneventfully and Figure 1 (D) shows the case three months after treatment.

The second case involved a lower left second molar of a 40 year-old individual (F. Sch.). There was a periapical as well as a periodontal involvement of this tooth. Root canal treatment had been previously done. A deep pocket had formed on the buccal surface of the mesial root, whereas the distal root appeared in good health. Repetition of the endodontic treatment was not deemed feasible. The tooth was divided into a mesial and a distal half. The mesial root was extracted. A crown was placed on

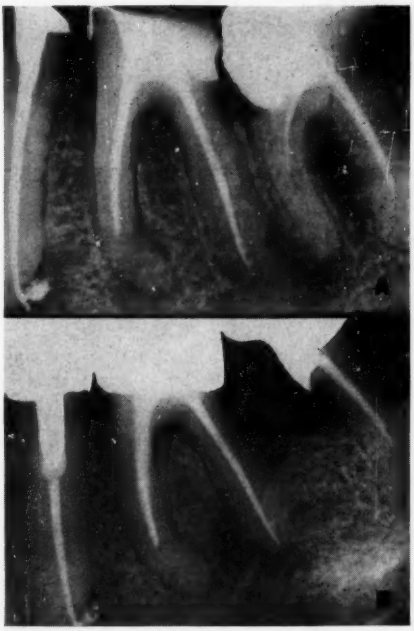

Fig. 2. Lower left second molar. Mesial root had periapical as well as periodontal involvement (A). Tooth was cut into mesial and distal halves—the mesial half extracted and a fixed bridge constructed (B).

the distal half of this tooth and the missing mesial half was replaced by a bridge pontic. This case was treated twelve years ago and the tooth is still functioning. Figure 2 (A) shows the case at the time of examination and Figure 2 (B) shows it ten years later.

The following cases which were similarly treated are recalled. A 40 year-old patient (Dr. H. P.) developed a deep pocket on the disto-buccal root of the upper right first molar which had been root-canal treated several years previously. The root was amputated at the cemento-enamel junction and the exposed tooth surface polished. After fifteen years, the patient still has the tooth in good functioning condition.

Another patient (B. E.), 35 years of age, developed a deep pocket and an abscess on the lingual root of the upper left first molar—a root canal treated tooth. This root also showed a periapical area of bone resorption due to a chronic inflammatory reaction. The root was amputated and the tooth is functioning on the two unaffected buccal roots.

A few similar cases have been described and shown in the book by B. Gottlieb and B. Orban, "Zahnfleisch Entzündung und Zahn Lockerung" (Gingival Inflammation and Loosening of the Teeth), which appeared in Berlin in 1933.

629 N. Nevada Ave.

## FOURTH NATIONAL CUBAN DENTAL CONGRESS

The Fourth National Cuban Dental Congress will be celebrated next November 12-16, 1954. It will be held at the Dental School, University of Habana. For further information write to Dr. Antonino Fernandez, Escuela de Odontologia, Universidad de la Habana, Habana, Cuba.

## AMERICAN ACADEMY OF PERIODONTOLOGY MEETING, MIAMI BEACH, FLORIDA

November 4, 5 and 6, 1954

HEADQUARTERS, EMPRESS HOTEL, MIAMI BEACH

*Scientific Program*

*Thursday, November 4, 1954:*

11:00-11:30 a.m. *Important Advances in Periodontal Research and Their Clinical Implications.*
Harold Ray ..... San Francisco, California

11:30-11:45 a.m. *Discussor*
Lowell Peterson ..... San Francisco, California

11:45-12:00 a.m. *General Discussion*

LUNCHEON

P.M. Symposium: *The Role of Other Fields of Dentistry in the Prevention and Treatment of Periodontal Diseases.*

2:00- 2:30 p.m. *Physiology of Jaw Relations*
Harry Sicher ..... Chicago, Illinois

2:30- 3:00 p.m. *Operative Dentistry*
Sumter Arnim ..... Houston, Texas

3:00- 3:30 p.m. *Orthodontia*
Robert Moyers ..... Ann Arbor, Michigan

3:30- 4:00 p.m. *Fixed Bridges and Jacket Crown Prosthesis*
Charles Pincus ..... Beverly Hills, California

4:00- 4:30 p.m. *Removable Bridge Prosthesis*
Allison James ..... Beverly Hills, California

4:30- 5:00 p.m. *Discussor*
William Branstad ..... St. Paul, Minnesota

*Friday, November 5, 1954:*

9:00- 9:30 a.m. *A New Concept of the Epithelial Attachment and Gingival Pocket.*
Jen Waerhaug ..... Oslo, Norway

9:30-10:00 a.m. *A Concept of the Epithelial Attachment and Gingival Pocket.*
Harry Sicher ..... Chicago, Illinois

10:00-10:30 a.m. *Role of Calculus in Relation to the Epithelial Attachment and Gingival Pocket.*
Helmut Zander ..... Minneapolis, Minnesota

10:30-11:00 a.m. *Role of Bacteria in the Gingival Pocket.*
Keith Box ..... Toronto, Canada

11:00-11:30 a.m. *Control of Bacteria in the Gingival Pocket.*
Holmes Knighton ..... Richmond, Virginia

11:30-12:00 a.m. *Discussion of Clinical Implications of Above.*
B. O. A. Thomas ..... Bethesda, Maryland

12:00- 2:30 p.m. *Round Table Luncheon*

2:30- 3:15 p.m. *Physiology of Connective Tissue*
Milton Engel ..... Chicago, Illinois

3:15 -4:00 p.m. *Experimental Evidence of Reattachment*
Sigurd Ramfjord ..... Ann Arbor, Michigan

4:00- 4:45 p.m. *Treatment Methods and Clinical Evidence of Reattachment.*
Frank E. Beube ..... New York, New York

4:45- 5:00 p.m. *General Discussion*

7:00 p.m. ANNUAL BANQUET

*Saturday, November 6, 1954:*

9:00-11:00 a.m. *Round Table Discussion: Wound Healing and Its Relation to Various Methods of Periodontal Therapy.*

9:00- 9:30 a.m. *Physiological and Histological Aspects of Healing.*
Joseph Brenier ..... Washington, D. C.

9:30-10:00 a.m. *Histochemical Aspects of Healing*
Milton Engel ..... Chicago, Illinois

10:00-10:30 a.m. *Chemical and Roentgenographic Aspects of Healing*
C. Kenneth Collings ..... Dallas, Texas

10:30-10:45 a.m. *Exchange of Questions between Members on Panel.*

10:45-11:00 a.m. *General Discussion*

*Clinic Program begins at 2:00 p.m.*..... Tolar Hamblen, Chairman

*Pathogenesis of Periodontal Disease*
John M. Nabors ..... Wichita Falls, Texas

*The Treatment and Management of the Pathological Diastema*
George F. Kirkland ..... Durham, North Carolina

*Physiological Fixed Restoration of Mouths Mutilated by Periodontal Disease*
Charles F. Pincus ..... Beverly Hills, California

*Occlusal Equilibration*
Captain F. E. Jeffreys ..... U. S. N.
Lt. Robert L. Platner ..... U. S. N. R.

*Technique of Gingivoplasty* (Movie)
C. F. Cornell ..... Havana, Cuba

All members of the American Dental Association are invited to attend the 4th National Cuban Dental Congress in Havana, Cuba. See page 215.

## COLLEGE OF PHYSICIANS AND SURGEONS

A refresher course in Periodontics will be held at the College of Physicians and Surgeons—October 19 through October 23rd. Other courses are being planned for 1954.

The course is being conducted by Dr. A. W. Ward, Dr. Clarence Butler, Dr. Robert L. Roseberry, Dr. John K. Young, and Dr. V. John Oulliber.

Patients are provided for the practical work.

Send application to the College of Physicians and Surgeons, Periodontics—Post-graduate Committee, 344 14th Street, San Francisco 3.

# *Announcements*

## ESTABLISHMENT OF THE UNITED STATES ARPA

(Association for Paradentosis Research)

At a regular meeting of the California Academy of Periodontology February 9, 1954 the Academy accepted the official invitation of the International ARPA to become a member organization in the United States, to be known as the United States ARPA. The presiding officer of the Academy will automatically be the President of this national organization. The names of the present officers for the year 1954 are:

Dr. Samuel Bleadon, President
Dr. R. Thomas Dunkin, Vice President
Dr. Howard J. Mallon, Recording Secretary
Dr. Elmer G. Smith, Financial Secretary
Dr. Clarence E. Butler, Treasurer

The International ARPA was founded May 31, 1932 by 5 prominent European specialists in the field of paradentology: Drs. R. Jaccard and A. J. Held from Switzerland, Dr. C. H. Hulin, France; and Drs. O. Weski and O. Loos from Germany. The objectives of this International ARPA were formulated as follows:

1. To promote scientific research in the field of paradental disease.
2. To maintain close collaboration between physicians and specialists in paradental disease.
3. To promote an exchange of ideas and objectives pertaining to paradental disease on an INTERNATIONAL basis by means of conventions and publications of reports and papers.
4. To coordinate efforts of the various national ARPA's with those of the individual associated members.

A quarterly journal which carries articles in various languages and which includes after each one a summary in English, is published in Geneva and is available to each member at a cost of $3.00 annually.

At the present time the International ARPA includes organizations in Switzerland, France, Denmark, Germany, England, Italy, Spain, Chile, Argentina, Peru, Brazil, Uruguay, Hungary, Australia, Czechoslovakia, Holland, Norway and probably several others.

The next Congress of the International ARPA will take place in Venice September 6 to 12, 1955. A Program Committee for this Congress has been appointed with Dr. Hermann Becks, San Francisco, as chairman. The function of this committee is to select clinicians and essayists from the ranks of the United States ARPA and also from the dental profession of the United States at large. Anyone interested in participating in lecture presentations or clinics at the Venice Congress is requested to write to Dr. Hermann Becks, the George Williams Hooper Foundation for Medical Research, Medical Center, University of California, San Francisco 22, California.

## BETH ISRAEL HOSPITAL

The Teaching Division of the Dental Department of the Beth Israel Hospital announces a two week conference and seminar in Periodontology Sept. 13th to the 24th, 1954.

The objective of this seminar is to present to the practitioner all of the techniques employed in periodontal therapy as well as theoretical background.

For further information write to Dental Department, Beth Israel Hospital, 330 Brookline, Ave., Boston, Mass.

## TEMPLE UNIVERSITY ANNOUNCES A COURSE IN CLINICAL OCCLUSION

*By Dr. Lewis Fox, South Norwalk, Conn.*

A course designed to present the fundamentals of occlusion in relation to the physiology and pathology of the periodontal supporting tissues. The entire course will be directed toward correlating the principles of occlusion to clinical criteria and therapeutic endeavors. Includes lectures, seminar conferences and clinical demonstrations.

This course will be given January 26, 27, 28, 1955, and is limited to twenty-five persons. Tuition $150.00.

Applications can be made to:

Dr. Lewis Herman
Director of Postgraduate Studies
Temple University School of Dentistry
3223 North Broad Street
Philadelphia 40, Pennsylvania

## THE AMERICAN INSTITUTE OF DENTAL MEDICINE

*Case History Service*

The Institute is issuing again for the year 1953-54, under an educational extension division, Case Histories from the broad field of Dental Medicine. These will be accompanied by original 35 mm. kodachrome slides of the oral condition, pertinent laboratory fiindings, medical background, roentgenograms, histologic slides, photomicrographs and whatever may be indicated in each individual case.

This monthly service started January 1953 and has met with unprecedented success. Any member of the A.D.A. or A.M.A., or their foreign equivalent, is eligible to apply.

Anyone subscribing to this Case History Service is entitled to full membership in the American Institute of Dental Medicine for the fiscal year. There are still available a few case histories for the year 1952-53. Further information may be obtained from the Executive Secretary, Miss Marion G. Lewis, 2240 Channing Way, Berkeley 4, California.

## THE AMERICAN INSTITUTE OF DENTAL MEDICINE

The next Annual Meeting of the Institute will take place at the Desert Inn, Palm Springs, California, October 31 to November 4, 1954. The faculty will consist of:

William A. Albrecht, Ph.D., University of Missouri, Columbia, Missouri: Soil and Nutrition. I. Evidence from Soil Exploitation. II. Services from Soil Treatments; "Let Rocks Their Silence Break"; Droughts. The Soils as Reasons for Them.

Charles H. Best, M.D., D.Sc., University of Toronto, Toronto, Canada: The History and Action of Insulin; Recent Work on Carbohydrate and Fat Metabolism; Dietary Factors in the Protection of Liver, Kidneys and Heart.

Gordon M. Fitzgerald, D.D.S., University of California, San Francisco: X-ray Radiation, Its Dynamics and Management; Radiation Protection Planning for the Dental Office; Practical Roentgenographic Interpretation in Dental Medicine.

Maynard K. Hine, D.D.S., Indiana University, Indianapolis, Indiana: Principles of the Treatment of Periodontal Disease; Oral Microbiology; Diseases of the Tongue and Other Oral Lesions.

Ernest Jawetz, Ph.D., M.D., University of California, San Francisco: The Rational Use of Antimicrobial Agents: Reason versus Emotion in Chemotherapy; Virus Infections of Interest to the Dentist and Therapeutic Approaches; The Rise and Fall of Focal Infection.

Joseph P. Weinmann, M.D., University of Illinois, Chicago, Illinois: The Adaptation of the Periodontal Membrane to Physiologic and Pathologic Changes; Bone Formation and Bone Resorption; Variations in the Structures of Bone Tissue and Their Significance in Radiology.

All Seminar lecturers will participate in a round table forum concerning the application of their subject to the practice of Dental Medicine. Applications and full information may be secured from the Executive Secretary, Miss Marion G. Lewis, 2240 Channing Way, Berkeley 4, California.

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## UNIVERSITY OF MINNESOTA

An interesting Symposium on Periodontal Problems, under the direction of Dr. Helmut A. Zander, will be held on September 11 and 12, 1954, at the University of Minnesota, discussing—

I. *Tooth Mobility*—its objective measurement; the causes and correction.

II. *The Epithelial Attachment*—its role in health, disease, and calculus formation; and the effect on the attachment apparatus of all filling materials used in dentistry.

Dr. JENS WAERHAUG of Oslo, Norway; Dr. HANS R. MÜHLEMANN, Professor, University of Zurich, Switzerland; and Dr. HELMUT A. ZANDER will be discussants. Attendance limited.

*For further information*, write to Director, Center for Continuation Study, University of Minnesota, Minneapolis 14, Minnesota.

## UNIVERSITY OF ILLINOIS, COLLEGE OF DENTISTRY

### A WORKSHOP IN PERIODONTAL PATHOLOGY DESIGNED OFR DENTAL TEACHERS

Dr. J. P. Weinnman and Staff

September 7-10, 1954

I. Oral Mucosa, Gingiva and Epithelial Attachment
II. Alveolar Bone, Periodontal Membrane and Cementum
III. Inflammation of the Gingiva
V. Functional Disturbances of the Periodontal Structures
IV. Periodontitis and Periodontosis
VI. Effect of Treatment (Prophylaxis, Gingivectomy and Reattachment)
VII. Oral Manifestations of Dermatological Diseases
VIII. Oral Manifestations of Blood Diseases

The treatment of each subject will consist of a one-hour lecture demonstration and discussion, and two hours of laboratory study of selected microscopic slides.

This course is limited in enrollment. Tuition fee: $25.00.

For further information write Dr. Isaac Schour, 808 S. Wood Street, Chicago 12, Illinois.

## LOYOLA UNIVERSITY SCHOOL OF DENTISTRY

Two postgraduate courses are offered at Loyola University School of Dentistry for the 1954-1955 season under the direction of Dr. Balint Orban and staff. "Problems of Occlusion in Periodontics" will be given October 21-23, 1954. Fee $100.00. "Theory and Practice of Periodontics" will be given January 20-22, 1955. Fee $100.00.

Classes will be limited to 20. For further information write to F. M. Wentz, Director of Postgraduate Division, 1757 West Harrison Street, Chicago 12, Illinois.

## COLLEGE OF DENTISTRY
## THE OHIO STATE UNIVERSITY

The College of Dentistry, Ohio State University, will present a series of postgraduate courses in dentistry during the months of September and October, 1954. These courses are given for five consecutive days each, Monday through Friday, and the enrollment is limited to approximately ten in each class so that intimate teaching is possible. One on Periodontics will be given Sept. 20-24 by Dr. John R. Wilson. Further information and application may be secured from College of Dentistry, Ohio State University, Columbus, Ohio.

# Letters to the Editor

Margolis'* paper, "Treatment Planning of Deep Overbite Cases," intimates that only overbite of excessive depth may be a problem for the periodontist. It seems to be important to recognize that excessive deep overbite does not always cause periodontal involvement. However, we must be aware that even moderately deep overbite can be the actual cause of periodontal destruction. Cases in which periodontal involvement is characterized by the mobility of the upper anterior teeth which are in premature contact in the occluding position and are labially displaced any time the mandible occludes have to be treated in regard to the overbite.

Margolis recommends that several precautions should be followed in the use of the Hawley appliance and one is that no greater opening than one millimeter should be used in separating the molars. He believes that such a Hawley, in order to increase vertical dimensions and therefore help to correct the overbite, should be worn all the time including the period of mastication. The maxillary teeth are capable of extrusion along with their periodontium and therefore coming in contact at an earlier time and then the Hawley can be remade opening it again another millimeter—never more. Furthermore he states that these appliances are usually worn at least a year and sometimes after their removal the teeth become subsequently depressed so that the case is back to status quo.

In regard to the method of treatment with the plate appliance which is a modification of a type of orthodontic appliance designed by M. A. Schwarz from Vienna called the bite plate, we follow an entirely different way of procedure.

1. The bite plate has to be constructed at least 1½ millimeters within the free way space from physiologic rest position without any other limitations. That means that the bite wall remains in the same plane from the beginning and for an indefinite period of time.

2. The patient wears the appliance day and night but never during meals since the stimulation and control of the masticatory function are most essential in obtaining a favorable result, particularly in regard to the new occlusion which has to be established. Continuous wearing of such an appliance would lead to an expansion in the upper molar region by tipping which is most undesirable.

3. Margolis' interpretation of the tooth movement indicates that only the maxillary teeth are in the movement. He uses the term extrusion while we prefer to name it active eruption or elevation. Contrary to that opinion we have definite proof that also the mandibular teeth are changing their position in regard to the occlusal plane and may participate to a greater extent in the establishment of the new occlusal plane since they are not retained at all by the appliance.

4. The average duration of the treatment is about four to five months with extreme exceptions both ways in which the period may be shortened to two months or extended to one and one-half years. This factor is independent of age but observation has shown that the rapidity of the active eruptions depends on the amount of stress the molar and bicuspid areas were subjected to before the insertion of the appliance. The greater the previous load has been the more rapid the growth occurs. Therefore we find in cases of very heavy

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*Given at the 37th American Academy of Periodontology in Cleveland, Ohio October 1953, and reviewed in abstract form in the Journal of Periodontology 25:67, 1954.

night grinding that the opening of the bite occurs when the appliance is worn only eight hours a day.

5. The results obtained cannot be considered as permanent unless they are kept in retention and the originally constructed appliance itself is to be used as a retentive appliance which is worn at night only for an indefinite period of time.

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Dear Doctor Hine:

Good terminology is generally accepted to be of importance particularly in science. Two of he terms used when referring to a certain type of periodontal pocket are "intrabony"[1] and "infrabony"[2] pocket. Such a clinical entity exists and is of clinical importance; it is therefore necessary to have a name for it. However, the terms used seem to have certain shortcomings. The root word "-bony" permits the misinterpretation that the pocket or space described is located below or within *bone* or that it is bounded by *bone*, as "bony" may refer not only to an organ—the alveolar bone in our case, but may refer also to bone as a tissue.[3] For this reason the Committee on Nomenclature of the American Academy of Periodontology suggested in their 1949 report that the term "intrabony" should be deleted as soon as a more satisfactory one were found.[4] Subsequently Sicher suggested for the entity under discussion the name "intra-alveolar" pocket.[5]

In all definitions the "intra-" or "infra-bony" pocket is described as a periodontal pocket, the bottom of whcih is located apically to the crest of the adjoining alveolar bone.[4,6] In order to eliminate the root word "-bony," and so as to comply with the specifications of the definition I should like to propose for this entity the term "sub-crestal" pocket.

To be sure, this term is also imperfect, as it combines a Latin prefix with an English root, and because in an upper tooth the prefix "sub" is actually incorrect. The name "sub-crestal" is, however, in my opinion preferable to the older terms in that it eliminates the ambiguous and misleading root word "-bony" and substitutes for it "-crestal," thereby establishing the crest of the alveolar bone as the critical landmark, which it is according to the accepted definition for this periodontal disease entity.

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